WL-TR-94-4052
Volume 1, Chapters 1, 2, 3 and 4

DAMAGE TOLERANT DESIGN HANDBOOK

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May 1994
Final Report for Period June 1991 - May 1994

Materials Directorate
Wright Laboratory
Air Force Materiel Command
Wright Patterson AFB, Ohio 45433-7734

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE MAY 1994

3. REPORT TYPE AND DATES COVERED FINAL 06/19/91--05/19/94

4. TITLE AND SUBTITLE
DAMAGE TOLERANT DESIGN HANDBOOK
VOL 1, CHAPTERS 1,2,3 AND 4

5. FUNDING NUMBERS
C F33615-91-C-5610
PE 62102
PR 2418
TA 04
WU 91

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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300 COLLEGE PARK
DAYTON OH 45469-0120

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
MATERIALS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7734

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
WL-TR-94-4052

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report presents a compilation of mechanical property data that are useful for damage tolerant design and analyses. The data of this handbook combines the old data that were previously presented in MCIC-HB-OIR (Damage Tolerant Design Handbook, December 1983) and more recent data that were collected from various sources. The fracture toughness, crack growth, R-curve, sustained load and threshold data are for alloy and stainless steels, nickel based super alloys, titanium alloys and aluminum alloys.

14. SUBJECT TERMS
MECHANICAL PROPERTIES
FRACTURE TOUGHNESS
SUBCRITICAL CRACK GROWTH
R-CURVES
SUSTAINED LOAD
THRESHOLD

15. NUMBER OF PAGES 747

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED

18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED

19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED

20. LIMITATION OF ABSTRACT UL

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Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

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★U.S.GPO:1990-0-273-271

Table of Contents

VOLUME 1

VOLUME 2

VOLUME 3

VOLUME 4

VOLUME 5

Foreword

This report summarizes the results of a damage tolerant, material property data collection and reporting program conducted under USAF Contract F33615-91-C-5610. The work was sponsored by the Materials Directorate of Wright Laboratory with Mr. Jack Coate of the Systems Support Division serving as the project monitor. The technical effort was conducted between June 1991 and January 1994. The work was performed by the University of Dayton Research Institute under the general supervision of Dr. Joseph P. Gallagher with Dr. Alan P. Berens serving as Principal Investigator.

This final report comprises eight chapters which are presented in five volumes as follows:

VOLUME	CHAPTER	DESCRIPTION
1	1	Handbook organization and content
	2	Methods of calculation
	3	Alloy Steels
	4	Stainless Steels
2	5	Nickel Based Super Alloys
	6	Titanium Alloys
3	7	Aluminum 2000/6000 Series Alloys
4 & 5	8	Aluminum 7000/8000 Series Alloys

A detailed listing of the materials represented in the Handbook is contained in the preceding Table of Contents. In the body of the Handbook, the pages are numbered within chapters and the relevant portion of the table of contents is repeated at the beginning of each chapter.

Table of Contents

List of Illustrations

Figure **Page**

List of Tables

CHAPTER 1

HANDBOOK ORGANIZATION AND CONTENT

1.0 OVERVIEW

The format of the Damage Tolerant Design Data Handbook has been modified slightly since the previous update in 1983. Data are still presented in material chapters and sorted by alloy within the chapters. Available alloy property data are then presented in a consistent order from chapter to chapter. This organization was suggested by aerospace engineers as the format best suited for their use. Additionally, this format conforms to other aerospace structural metals handbooks such as the Military Handbook-5 and Aerospace Structural Metals Handbook.

A survey was conducted at the beginning of this handbook program. A number of aerospace design, materials, and structural engineers were canvassed for their comments relative to the handbook organization, formats, summaries and data types. It was agreed that the overall format of the 1983 edition of the handbook was generally acceptable. The page numbering scheme in the 1993 edition transitioned to sequential page numbers within chapters to facilitate looking up alloy data. The table of contents on the first page of each material chapter lists the alloys in the chapter along with their starting pages.

Mean trend fatigue crack growth and sustained crack growth data are now listed on the same page as the plots of their crack growth rate data. If available, the root mean square percent error and life prediction ratio for these data are also listed on the same page. This new format removes confusion about the relationship of crack growth data to their fitted mean trend data.

Data are presented in English units throughout the handbook, i.e., Ksi$\sqrt{}$in for fracture toughness and applied stress intensity factor levels, and inches/hr or inches/cycle for crack growth rates. Metric units have been incorporated along with

the English units on the graphical presentation of the sustained load and fatigue crack growth rate data, but limited space forced the exclusion of metric units from the tabular data.

1.1 ORGANIZATION

The handbook is divided into eight chapters and consists of five volumes. The order of the chapters are as designated in Table 1.1. Following the first chapter on handbook usage and the second chapter on methods of calculations are the six material chapters. This order was selected to keep the data for a particular chapter together as much as possible while keeping the volume sizes reasonable and approximately equal.

TABLE 1.1

ORDER OF HANDBOOK CHAPTERS

Volume Number	Chapter Number	Chapter Title
1	1	Handbook Organization, Contents, and Formats
1	2	Methods of Calculation
1	3	Alloy Steels
1	4	Stainless Steels
2	5	Nickel Base Alloys
2	6	Titanium Alloys
3	7	2000/6000 Series Aluminum Alloys
4-5	8	7000/8000 Series Aluminum Alloys

Each material chapter contains a section of material summaries and three subsequent sections containing data pertinent to individual material alloys. Table 1.2 presents the basic organization of each material chapter and reflects the naming conventions for tables and figures found therein. The first number of any section,

TABLE 1.2

ORGANIZATION OF HANDBOOK DATA CHAPTERS

MATERIAL SUMMARIES		
C.0.1	Table	Available Data
C.0.2	Table	Plane Strain Fracture Toughness K_{Ic}
C.0.3.1	Table	Plane Stress and Transitional Fracture Toughness K_c (Buckling Not Constrained)
C.0.3.2	Table	Plane Stress and Transitional Fracture Toughness K_c (Buckling Constrained)
C.0.4(.*s*)	Table	Fatigue Crack Growth Rate Comparison
C.0.5	Table	Stress Corrosion Cracking Threshold K_{Iscc}
SPECIFIC ALLOY DATA		
Alloy Summaries		
C.A.1.1	Table	Plane Strain Fracture Toughness
C.A.1.2(.*s*)	Table	Fatigue Crack Growth Rate Comparisons
Alloy Fracture Toughness Data		
C.A.2.1	Table	Plane Strain Fracture Toughness K_{Ic}
C.A.2.2	Table	Plane Stress and Transitional Fracture Toughness K_c
C.A.2.3(.*s*)	Figure	R-curve Plots
Alloy Subcritical Crack Growth Data		
C.A.3.1(.*s*)	Figure	da/dN-vs-ΔK Plots and Mean Trend Fatigue Crack Growth Rate Data
C.A.3.2(.*s*)	Figure	da/dt-vs-K_{max} Plots and Mean Trend Sustained Load Crack Growth Rate Data
C.A.3.3	Table	Stress Corrosion Cracking Threshold K_{Iscc}

C - material chapter number
A - alloy sequence number
(.*s*) - sequence number when multiple tables or figures exist for specific test conditions

subsection, table or figure number refers to the material chapter as specified in Table 1.1. A zero in the second position indicates that the data is a material summary. Consecutive sequence numbers originating at one are assigned to alloys as the second number in the numbering scheme. The alloy sequence numbers are defined on the index page of each material chapter. The material bibliography is assigned the sequence number immediately following the last alloy in the material chapter.

In the material summary section, *C*.0..., where *C* represents a material chapter number, five types of material summary tables may be listed as subsections. Tables will be listed in the order defined by Table 1.2. If, however, not enough data are available for a particular summary, this summary is not printed and its sequence number is skipped. Section 1.3 describes the formats for material summaries.

In the alloy section, *C.A*..., where *C* represents material chapter number and *A* represents alloy number, the third number in the sequence will designate whether the data are an alloy summary (*C.A.*<u>1</u>), fracture toughness data (*C.A.*<u>2</u>), or crack growth resistance data (*C.A.*<u>3</u>). Within each subsection, data tables and graphs are ordered consecutively. If, however, insufficient data are available to generate a table or figure, the table or figure in question does not appear and the sequence number is skipped.

Section 1.4 discusses the formats of two alloy summaries: plane strain fracture toughness and fatigue crack growth rate. Section 1.5 discusses the data formats of three types of fracture toughness data: plane-strain fracture toughness, plane stress and transitional fracture toughness, and resistance curve. Section 1.6 discusses the data formats of three types of subcritical crack growth data: fatigue crack growth rate, sustained load crack growth rate, and stress corrosion cracking threshold.

To help the handbook user locate data, examples of actual tables and figures are included in the discussions of the handbook subsections which follow. These examples are presented to familiarize the user with the formats presented in the handbook. The discussion follows the same order as that found in the handbook.

1.2 DATA ORDERING AND ABBREVIATIONS

1.2.1 Sorting Order

Data fields in the handbook database exist in one of three formats: text, numeric, or coded. The ASCII (American Standard Code for Information Interchange) collating sequence (Table 1.3) defines the sort order for text fields such as alloy, condition/heat treat, and environment. Letters are case insensitive in text fields, i.e., lower case letters are treated as their upper case equivalents. Numeric fields are presented in ascending order (most negative to most positive). Test temperature is a numeric field that has a minor exception in that temperatures from 65°F to 80°F are grouped as room temperature and are considered equal. Coded fields are ordered on their code value according to the ASCII collating sequence. Table 1.4 presents three such coded fields: product form, specimen design, and specimen orientation. Existing codes and their equivalent values are given in coded order. Note that the equivalent values are used in the presentation of material data.

1.2.2 Abbreviations

The material chapters present tables and figures summarizing material property data. Abbreviations are used throughout the tables and figures in these chapters for the following five data fields: 1) condition/heat treatment, 2) product form, 3) environment, 4) specimen design, and 5) specimen orientation. Abbreviations and expanded descriptions used in the presentation of these data types can be found in Tables 1.5 through 1.8 and Figure 1.1, respectively.

1.3 MATERIAL CHAPTER SUMMARIES

Material summaries are presented at the beginning of each chapter before alloy summaries and detailed data. These summaries are meant to aid in comparing material properties and selecting materials for design. There are five data types (see

TABLE 1.3

AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE (ASCII) CONVERSION TABLE

Decimal Value	ASCII Character	Decimal Value	ASCII Character	Decimal Value	ASCII Character
32	(space)	64	@	96	‘
33	!	65	A	97	a
34	"	66	B	98	b
35	#	67	C	99	c
36	$	68	D	100	d
37	%	69	E	101	e
38	&	70	F	102	f
39	’	71	G	103	g
40	(	72	H	104	h
41	)	73	I	105	i
42	*	74	J	106	j
43	+	75	K	107	k
44	,	76	L	108	l
45	-	77	M	109	m
46	.	78	N	110	n
47	/	79	O	111	o
48	0	80	P	112	p
49	1	81	Q	113	q
50	2	82	R	114	r
51	3	83	S	115	s
52	4	84	T	116	t
53	5	85	U	117	u
54	6	86	V	118	v
55	7	87	W	119	w
56	8	88	X	120	x
57	9	89	Y	121	y
58	:	90	Z	122	z
59	;	91	[	123	{
60	<	92	\	124	|
61	=	93	]	125	}
62	>	94	^	126	~
63	?	95	_	127	⌂

TABLE 1.4

SORT ORDER FOR CODED HANDBOOK DATA FIELDS

PRODUCT FORM			
01	Sheet	09	Welded & Stress Relieved
02	Plate	10	Weldment
03	Forging	11	Disk
04	Extrusion	12	Extruded Bar
05	Forged Bar	13	Rolled Bar
06	Billet	14	Bar
07	Casting	15	Hand Forging
08	Round Bar		
SPECIMEN DESIGN			
01	Compact Tension (CT)	11	Charpy
02	Center Cracked Panel (CCP) (max load specified)	12	Cantilever (Side Grooved)
03	Center Cracked Panel (CCP) (max stress specified)	13	Part Through Surface Crack (PTSC) (max load specified)
04	3-point Notched Bend (3-NB)	14	Single Edge Notched Tension (SENT)
05	Center Notch Tension (CNT)	15	Old Compact Tension
06	Wedge Open Loading (WOL)	16	K_B Bar
07	Bolt Loaded WOL (BWOL)	17	4-point Notched Bend (4-NB)
08	Cantilever Beam (CB)	18	Bend Specimen - Side Grooved
09	Double CB (DCB)	19	Part Through Surface Crack (PTSC) (max stress specified)
10	Tapered DCB (TDCB)	20	Modified Compact Tension (MCT)
SPECIMEN ORIENTATION			
01	L-S	10	R-L
02	L-T	11	R-C
03	T-S	12	C-R
04	T-L	13	---
05	S-T	14	L-T45
06	S-L	15	CS = C-L
07	L-C	16	SC = L-C
08	C-L	17	RS = R-L
09	L-R	18	SR = L-R

TABLE 1.5

ABBREVIATIONS FOR ALLOY CONDITION AND HEAT TREATMENT

Abbreviation	Condition/ Heat Treatment
ABQ	Aus-Bay Quench
AC	Air Cool
BA	Beta Anneal
DA	Duplex Anneal
HAZ	Heat Affected Zone
MA	Mill Anneal
OQ	Oil Quench
RA	Recrystallize Anneal
ST	Solution Treated
STA	Solution Treated and Aged
WC	Water Quench

TABLE 1.6

ABBREVIATIONS FOR PRODUCT FORM

Abbreviation	Product Form
B	Bar
BR	Round Bar
BT	Billet
C	Casting
D	Disk
E	Extrusion
EB	Extruded Bar
F	Forging
FB	Forged Bar
HF	Hand Forging
P	Plate
RB	Rolled Bar
S	Sheet
W	Weldment
WSR	Welded & Stress Relieved

TABLE 1.7

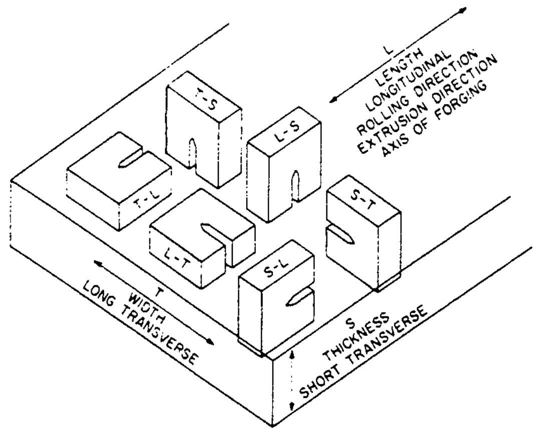
ABBREVIATIONS AND TERMS FOR TEST ENVIRONMENT

Abbreviation	Test Environment
3.5% NACL	3.5% Salt Water Solution
CCL4	Carbon Tetrachloride
DIST WATER	Distilled Water
DRY AIR	Low Humidity Air (<10% RH)
F.C.S.	Field Cleaning Solvent
H.H.A.	High Humidity Air (>80% RH)
H2O	Water
H2O(D)	Distilled Water
JP4	JP-4 Jet Fuel
L.H.A.	Low Humidity Air (<10% RH)
LAB AIR	Laboratory Air (RH unspecified)
S.C.S.	Shop Cleaning Solvent
S.S.W.	Simulated Seawater
S.T.W.	Sump Tank Water
SALT FOG	Salt Fog

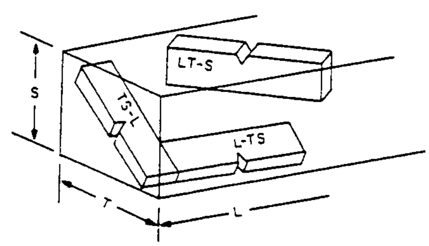
TABLE 1.8

ABBREVIATIONS FOR SPECIMEN DESIGN

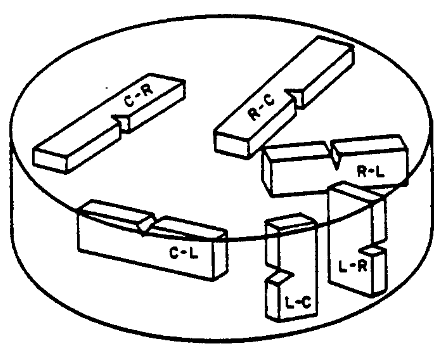
Abbreviation	Specimen Design
4-NB	4-point Notched Bend
BDCB	Bolt-loaded Double Cantilever Beam
BWOL	Bolt-loaded Wedge Open Loading
CANT	Cantilever Beam
CCP	Center Cracked Panel
CHAR	Charpy
CNT	Center Notched Tension
CT	Compact Tension
DCB	Double Cantilever Beam
K_BBAR	K_B Bar
MCT	Modified Compact Tension
NB	Notched Bend
PTSC	Part Through Surface Crack
SENT	Single Edge Notched Bend
TDCB	Tapered Double Cantilever Beam
WOL	Wedge Open Loading



(a) Crack Plane Orientation Code for Rectangular Sections



(b) Crack Plane Orientation Code for Rectangular Sections where Specimens are Tilted with Respect to the Reference Directions



(c) Crack Plane Orientation Code for Bar and Hollow Cylinder

Figure 1.1 ASTM Abbreviations Used to Describe Specimen Orientations

Material Summaries in Table 1.2) for which material summaries are possible. Each summary compares availability or properties of damage tolerant data for the given alloys, heat treatments, and product forms of a particular material.

1.3.1 Available Data Summary

Figure 1.2 presents the fourth page of the available data summary for Aluminum 7000/8000 labeled as TABLE 8.0.1. The first number in the table number is "8" which indicates that this table belongs to the eighth chapter; the second number is "0" which indicates that this is a table in the material summary section. The third number is "1" which indicates that this is the "Available Data" table for this material.

The available data summary defines the property data that are available in a chapter by alloy, condition/heat treatment, and product form. The number is each data type cell in Figure 1.2 indicates the number of test specimens recorded in the handbook database for the specific test conditions of alloy, heat treat, and product form. The six different types of data are listed across the top of the table. Alloys are listed in ASCII collating sequence which is how they appear in the handbook. Heat treatments and conditions are also sorted according to the ASCII collating sequence. Following the sort by alloy and condition/heat treatment, the property data are then sorted according to product form. Product form sort order is outlined above in Table 1.4.

1.3.2 Plane Strain Fracture Toughness Material Data Summary

Figure 1.3 presents the second page of the aluminum 7000/8000 plane-strain fracture-toughness data summary labeled as TABLE 8.0.2. This is the second type of material summary and its third table digit is "2". Data are sorted and grouped by alloy, condition/heat treatment, and product form. Data are listed only for specimens tested in laboratory air at room temperature (65°F - 80°F). Plane

TABLE 8.0.1 (CONTINUED)

AVAILABLE DATA FOR ALUMINUM 7000/8000 SERIES ALLOYS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
7075 (Cont'd)	T6510	Extrusion	33			5		
		Forged Bar	35					
		Extruded Bar				2		
	T6511	Forging				7		
		Extrusion	12		6	10		
	T6511 #6	Forging				1		
	T73	Sheet		27				
		Plate				3		
		Forging	20					1
		Forged Bar	4			17		
	T7351	Sheet		35				
		Plate	106	144		96	3	16
		Extrusion	32					
	T7351 53.2	Plate				2		
	T73510	Extrusion	12			6		
		Extruded Bar				3		
	T73511	Extrusion	27			26		
		Extruded Bar						5
	T73511-HIGH PURITY	Extrusion				4		
		Extruded Bar	4					
	T73511-LOW PURITY	Extrusion				5		
		Extruded Bar	4					

Figure 1.2 Sample Table (pg 8-6): Available Data Summary for Aluminum 7000/8000 Series Alloys

TABLE 8.0.2 (CONTINUED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALUMINUM 7000/8000 SERIES ALLOYS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$ Specimen Orientation L-T				T-L				S-L			
				Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev
7050 (Cont'd)	T74511	Extrusion	0.75-1.50	0.73	4	40.4	5.0	...	...	...	...	...	...	...	...
	T7452	Forging	4.00	1.00	2	31.1	1.2	1.00	3	23.5	3.0	...	...	...	...
	T7651	Plate	0.75-1.00	0.74	6	33.4	2.8	...	...	...	...	...	...	...	...
	T76511	Extrusion	0.75-1.50	0.73	3	34.8	5.5	...	...	...	...	...	...	...	...
	T7E56	Forging	5.00	...	...	...	...	0.75	4	28.9	3.9	...	...	...	...
7075	T6	Forging	0.50-0.89	0.50	2	24.3	0.1	0.25	2	20.9	1.7	0.50	4	16.8	0.4
		Extrusion	2.00	...	...	...	...	0.75	3	19.9	0.2	0.75	3	18.5	0.2
	T651	Plate	0.37-5.00	0.51	63	26.5	2.0	0.38	75	22.5	2.0	0.50	11	17.6	2.7
		Extrusion	3.00-5.00	1.50	4	31.1	0.5	1.50	5	20.2	0.2	...	...	...	...
		Rolled Bar	5.00	1.50	2	34.1	0.5	...	...	...	...	...	...	...	...
	T6510	Extrusion	0.68-3.50	0.50	12	27.5	2.1	0.50	16	23.3	1.6	0.25	3	20.0	1.3
		Forged Bar	0.68-5.00	0.62	13	29.2	3.4	0.50	13	21.4	1.8	0.25	7	18.7	0.9
	T6511	Extrusion	1.25	1.22	2	27.9	1.4	1.17	4	26.9	1.8	...	...	...	...
	T73	Forging	1.00	...	...	...	...	...	...	...	...	0.50	4	19.1	0.5
	T7351	Plate	1.00-4.00	0.51	47	29.4	2.2	0.51	36	26.2	3.2	0.50	7	18.5	0.4
	T73510	Extrusion	0.68-3.50	...	...	...	...	0.50	9	24.6	2.3	1.00	2	20.3	0.8
	T73511	Extrusion	3.50	1.63	4	39.6	3.1	1.75	3	26.8	1.1	1.00	2	21.9	1.1

Figure 1.3 Sample Table (pg 8-13): Plane Strain Fracture Toughness Values (Material Summary)

strain fracture toughness values and standard deviations mean are listed for the three most frequently occurring specimen orientations; i.e., L-T, T-L and S-L. Product thickness range and minimum specimen thicknesses are listed for general information. Dashes in a particular column indicate that no mean plane strain fracture toughness data exist for the stated conditions.

1.3.3 Plane Stress and Transitional Fracture Material Data Summary

The plane stress and transitional fracture toughness data summary is presented third in the series of summaries. Two tables may be presented for a material type if sufficient data are available. The first table (Figure 1.4a) presents test data for specimens where buckling constraints were not imposed. The sequence number for this type of table is *C*.0.3.1, where *C* is the material chapter number. The second table (Figure 1.4b) presents test data for specimens where buckling constraints were applied. The sequence number of this table is *C*.0.3.2, where *C* is the material chapter number. The third digit of the table number is always "3". Observe that the fourth digit is "1" and "2" for test specimens without and with buckling constraints, respectively. The data are sorted in both table types by alloy, condition/heat treatment, test temperature, specimen orientation and specimen width. Yield strength is not a sorting field but is included for general information. Mean K_c values are listed as a function of specimen thickness which is indicated across the top of the page. Specimen thickness variations run along the top of the page and may vary from table to table to prevent overcrowding in the tables while still accommodating all of the data. Individual K_c data values are listed only if useful in determining a trend in the data.

1.3.4 Fatigue Crack Growth Rate Material Data Summary

Figure 1.5 presents a sample fatigue crack growth rate (FCGR) summary taken from the Aluminum 7000/8000 Chapter. The data are from Table 8.0.4.2, a four number sequenced designation. The first two numbers again indicate

TABLE 8.0.3.1

PLANE STRESS AND TRANSITIONAL FRACTURE TOUGHNESS ALUMINUM 7000/8000 SERIES ALLOYS (WITHOUT BUCKLING CONSTRAINTS)

Alloy	Condition/ Heat Treatment	Test Temp (°F)	Specimen		Yield Strength (Ksi)	K_c (Ksi√in) Specimen Thickness (in.) n - Sample size μ - Mean σ - Standard Deviation														
						0.063			0.125			0.250			0.500			1.000		
			Orient	Width (in.)		n	μ	σ	n	μ	σ	n	μ	σ	n	μ	σ	n	μ	σ
7001	T75	R.T.	L-T	20.0	70.6-72.2	---	---	---	---	---	---	---	---	---	---	---	---	12	33.0	5.9
			T-L	3.0	67.7-68.6	---	---	---	12	39.5	2.6	---	---	---	---	---	---	---	---	---
				20.0	69.6-71.3	---	---	---	---	---	---	---	---	---	---	---	---	12	28.6	3.2
7075	T6	R.T.	L-T	15.0	73.5	---	---	---	---	---	---	---	---	---	2	64.0	12.7	---	---	---
				16.0	75.7-80.1	5	65.6	5.0	3	60.2	1.3	2	59.9	1.4	---	---	---	---	---	---
			T-L	3.0	72.9-77.0	---	---	---	8	51.5	2.5	---	---	---	---	---	---	---	---	---
				5.0	75.5	2	58.3	4.0	---	---	---	---	---	---	---	---	---	---	---	---
				15.0	73.3-76.0	---	---	---	---	---	---	2	57.2	3.7	2	49.3	.6	---	---	---
				16.0	72.9	5	62.1	3.4	---	---	---	---	---	---	---	---	---	---	---	---
				24.0	69.0-75.5	7	46.2	5.8	---	---	---	---	---	---	---	---	---	---	---	---
	T651	R.T.	L-T	3.0	77.3-79.1	---	---	---	3	52.6	2.9	2	46.2	.0	---	---	---	---	---	---
				4.0	77.3	---	---	---	---	---	---	2	61.3	4.6	---	---	---	---	---	---
				20.0	76.6-80.3	---	---	---	---	---	---	---	---	---	---	---	---	12	75.4	9.1
			T-L	3.0	73.4-77.7	---	---	---	9	48.6	1.2	16	43.9	3.2	---	---	---	---	---	---
				4.0	72.0-75.4	---	---	---	---	---	---	12	50.2	4.5	2	34.9	1.5	---	---	---
				15.0	77.2	---	---	---	---	---	---	---	---	---	2	47.8	2.6	---	---	---
				20.0	73.6-77.4	---	---	---	---	---	---	---	---	---	---	---	---	12	35.1	3.2
	T73	88.	L-T	16.0	60.0	2	82.9	3.6	---	---	---	---	---	---	---	---	---	---	---	---
	T7351	R.T.	L-T	8.0	61.1-62.1	---	---	---	---	---	---	---	---	---	9	61.4	10.4	3	45.8	5.3
				16.0	61.1-62.1	---	---	---	---	---	---	---	---	---	---	---	---	7	52.7	6.3
				20.0	60.6-64.6	---	---	---	---	---	---	---	---	---	---	---	---	12	96.6	10.9
				36.0	61.1-62.1	---	---	---	---	---	---	---	---	---	---	---	---	3	66.6	3.0
			T-L	20.0	63.6	---	---	---	---	---	---	---	---	---	---	---	---	4	46.4	1.2

Figure 1.4a Sample Table (pg 8-16): Plane Stress and Transitional Fracture Toughness without Buckling Constraints (Material Summary)

TABLE 8.0.3.2

PLANE STRESS AND TRANSITIONAL FRACTURE TOUGHNESS ALUMINUM 7000/8000 SERIES ALLOYS (WITH BUCKLING CONSTRAINTS)

Alloy	Condition/ Heat Treatment	Test Temp (°F)	Specimen		Yield Strength (Ksi)	K_c ($Ksi\sqrt{in}$) Specimen Thickness (in.) n - Sample size μ - Mean σ - Standard Deviation														
						0.058			0.080			0.090			0.100			0.280		
			Orient	Width (in.)		n	μ	σ	n	μ	σ	n	μ	σ	n	μ	σ	n	μ	σ
7050 (ALCLAD)	T76	R.T.	L-T	20.0	67.2	2	114.0	7.5	---	---	---	---	---	---	---	---	---	---	---	---
7075	T6	R.T.	L-T T-L	12.0	75.9	---	---	---	---	---	---	26	71.9	2.8	---	---	---	---	---	---
				15.0	76.2	---	---	---	---	---	---	---	---	---	---	---	---	2	76.6	.2
				24.0	75.9	---	---	---	---	---	---	---	---	---	2	71.5	.2	---	---	---
				36.0	75.9	---	---	---	---	---	---	---	---	---	5	72.8	6.0	---	---	---
				24.0	75.5	10	73.3	8.1	---	---	---	---	---	---	---	---	---	---	---	---
	T651	R.T.	L-T	8.0	78.3	6	63.4	5.5	---	---	---	---	---	---	---	---	---	---	---	---
	T7351	R.T.	L-T	36.0	60.5	---	---	---	---	---	---	---	---	---	---	---	---	2	119.8	23.9
7075 (ALCLAD)	T6	R.T.	L-T	6.0	73.1	---	---	---	6	60.1	5.0	---	---	---	---	---	---	---	---	---
				12.0	73.1	---	---	---	17	70.1	7.1	---	---	---	---	---	---	---	---	---
				24.0	73.1	---	---	---	20	69.2	10.4	---	---	---	---	---	---	---	---	---

Figure 1.4b Sample Table (pg 8-19): Plane Stress and Transitional Fracture Toughness with Buckling Constraints (Material Summary)

TABLE 8.0.4.2 (CONTINUED)

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR ALUMINUM 7000/8000 SERIES ALLOYS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: L-T   STRESS RATIO: -1.0 - 0.8   FREQUENCY: 0.08 - 40. Hz

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
7075 (Cont'd)	T651	PLATE	0.02	10			8.02	53.63		
			0.02	0.1-30				65.66		
			0.02	1-30		1.69	17.34	80.15		
			0.02	0.1-30				49.44		
			0.02	0.1-30				61.61		
			0.02			1.57	14.98	59.24		
			0.33	7.5			14.89			
			0.5	10		3.02	20.79	657.63		
		UNSPECIFIED	-0.5	2-5	0.09	0.74				
			-0.1	2-5	0.05	0.72	7.7			
			0.1	2-5		0.4	3.04			
			0.5	2-5	0.1	0.68				
	T6510	EXTRUSION	0.33	5.2			24.33			
		EXTRUDED BAR	0.33	5.2			17.11			
	T6511	FORGING	0.1	40	0.09	1.18				
			0.5	30	0.19					
		EXTRUSION	-1			1.01	13.77			
			-0.5			0.76	14.84	53.88		
			0.01			0.99	13.04	68.19		

Figure 1.5 Sample Table (pg 8-26): Fatigue Crack Growth Rate Comparison (Material Summary)

the chapter (8) and the summary section (0). The third number in the sequence (4) indicates that this is an FCGR summary table. The fourth number in the sequence (2) indicates that this is the second ordered table in the fatigue crack growth rate summary for a given material. When only a single FCGR summary table is available for a material, the fourth number in the sequence is dropped. Readers will find one table for each specimen orientation for which there are enough data for the table to have meaning.

All data in a particular summary table were collected under conditions where the environment is laboratory air at room temperature. The stress ratio and loading frequencies vary slightly depending on the individual tests. The range of test conditions are listed at the top of each table. Beneath the general description of test conditions are the data fields of alloy, condition/heat treatment and product form for which the FCGR data comparisons can be made. Predefined ΔK levels are listed across the top of the table and are a subset of the levels associated with the tabular format of the mean trend FCGR data. See Section 1.6 for a list of all predefined mean trend ΔK levels. Fatigue crack growth rates expressed in 10^{-6} inches/cycles are listed in the applicable columns and rows according to the alloy, condition/heat treatment, and product form. With this format, it is easy to determine which materials, heat treatments, or product forms have the lowest growth rate at a particular ΔK level.

1.3.5 Stress Corrosion Cracking Threshold Material Data Summary

Figure 1.6 illustrates the stress corrosion cracking threshold material data summary - the fifth possible material data summary. The sequence number assigned to this table type is *C*.0.5, where *C* is the material chapter number. Because of the small number of specimens (typically one or two) that are used to generate these data, individual results are presented here rather than means and standard deviations. The data are sorted by alloy, condition/heat treatment, product form and specimen orientation. Possible environments for which K_{Iscc} data exist are listed

TABLE 8.0.5 (CONTINUED)

STRESS CORROSION CRACKING THESHOLD DATA FOR ALUMINUM 7000/8000 SERIES ALLOYS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Specimen Orientation	K_{Iscc} $Ksi\sqrt{in}$ Environment: 3.5% NaCl	Shop Cleaning Solvent	Sump Tank Water	JP-4 Jet Fuel	Simulated Seawater
7049 (Cont'd)	T7352	Forging	L-T		26.6(2)	21		
			T-L			20(4)		
			S-L			18.6(4)		
7050	T736	Forging	L-T	28.2				
			T-L	24.5				
	T73651	Plate	T-L	29.1		27.8(2)		
	T7651	Plate	L-T				22.5(2)	22.(2)
			T-L				22.5	22.3(2)
7075	T6	Plate	S-L	19				
	T651	Plate	L-T	28.3				
			S-L	17				
	T73	Forging	T-L			25		
	T7351	Plate	L-T				28.7(4)	28.6(4)
			T-L	23.9				
			S-L	21		14.1(2)		

Figure 1.6 Sample Table (pg 8-42): Stress Corrosion Cracking Threshold (Material Summary)

across the top of the table. K_{Iscc} data values for each particular environment are listed in the appropriate row and column. This table summary allows for comparisons of K_{Iscc} values of various materials in a particular environment as well as a quick assessment of how various environments affect a particular material.

1.4 ALLOY SECTION SUMMARIES

Following the material summaries, the data are divided into sections by alloy. Each alloy section is further divided into three subsections: a data summary subsection, a fracture toughness subsection, and a crack growth resistance subsection. The data content and format for these three subsections are described in this and the following two subsections, respectively.

There are two possible alloy summaries: a plane strain fracture toughness summary and a fatigue crack growth rate data summary. Tables in these summaries are labeled *C.A.*1..., where *C* is the material chapter number, *A* is the alloy section number, and "1" identifies the alloy summary section. A fourth number appears on each table in this section. The numbers "1" and "2" in the fourth position indicate plane strain fracture toughness and fatigue crack growth rate, respectively. A fifth number is appended to the fatigue crack growth rate table number when multiple tables exist for an alloy.

Figure 1.7 presents the tabular format for the K_{Ic} alloy summary. It is similar to the K_{Ic} material summary in that the mean and standard deviation for a particular condition/heat treatment, product form, and specimen orientation is given for each alloy. However, the number of specimens used to generate the data has been added. The data are sorted by product form, condition/heat treatment, and specimen orientation. This summary groups K_{Ic} data by condition and product form for easy comparison. It also allows for quick assessment of the effect that orientation has on fracture toughness.

TABLE 8.9.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALUMINUM 7000/8000 SERIES ALLOY 7075 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$ Specimen Orientation L-T Mean K_{Ic}	L-T Std Dev	L-T n	T-L Mean K_{Ic}	T-L Std Dev	T-L n	S-L Mean K_{Ic}	S-L Std Dev	S-L n
Plate	T651	26.5	2.	63	22.5	2.	75	17.6	2.7	11
	T7351	29.4	2.2	47	26.2	3.2	36	18.5	0.4	7
	T7651	28.5	1.5	25	23.1	2.	45	17.8	1.5	16
Forging	T6	24.3	0.1	2	20.9	1.7	2	16.8	0.4	4
	T73	---	---	---	---	---	---	19.1	0.5	4
	T7352	33.6	3.1	14	26.6	2.8	13	21.7	3.2	8
	T73652	35.	1.8	3	26.6	2.7	3	---	---	---
Extrusion	T6	---	---	---	19.9	0.2	3	18.5	0.2	3
	T651	31.1	0.5	4	20.2	0.2	5	---	---	---
	T6510	27.5	2.1	12	23.3	1.6	16	20.	1.3	3
	T6511	27.9	1.4	2	26.9	1.8	4	---	---	---
	T73510	---	---	---	24.6	2.3	9	20.3	0.8	2
	T73511	39.6	3.1	4	26.8	1.1	3	21.9	1.1	2
	T76511	35.7	4.4	6	23.6	2.8	4	---	---	---

Figure 1.7 Sample Table (pg 8-452): Mean Plane Strain Fracture Toughness at Room Temperature (Alloy Summary)

The FCGR alloy data summaries shown in Figure 1.8 are similar to the FCGR material data summaries described previously. Note that for a particular alloy, the data are separated by the test variables of specimen orientation and environment which are listed at the top of each page. The sort order of specimen orientation is shown in Table 1.4 and environment is sorted alphabetically. Other test variables such as condition/heat treatment, product form, stress ratio and frequency are then listed for the data as noted. Typically, a number of FCGR data summaries are produced to describe the effects of specimen orientation and environments. The condition/heat treatment and product form yielding the lowest crack growth rate in a given environment for a given specimen orientation may be determined from these summary tables. Discrepancies in data sets can also be noted as well as a quick determination of how stress ratio and frequency affect the crack growth in a particular environment.

1.5 ALLOY FRACTURE TOUGHNESS SUBSECTION FORMATS

Within each alloy section following the alloy summaries is the fracture toughness type data. Fracture toughness data consist of plane strain data (K_{Ic}), plane stress and transitional fracture toughness data (K_c), and resistance curve data (R-curves). Each of these has a different and yet somewhat similar ordering scheme which is particularly suited to that type of data. Tables and figures in these sections are labeled *C.A.*2..., where *C* is the material chapter number, *A* is the alloy section number, and "2" indicates the fracture toughness section. A fourth number appears on each table and figure. The numbers "1", "2", and "3" in the fourth position indicate K_{Ic}, K_c, and R-curve, respectively. K_{Ic} and K_c tables may have multiple pages. Page sequence numbers are given to the upper right of each table. A fifth number is assigned to R-curve plots when multiple plots are available for an alloy.

TABLE 8.9.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 7075 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
T6	SHEET	0.	9			17.22			
		0.05	9		0.48	15.9			
		0.5	9	0.13					
		0.7	9		6.36	70.23			
T651	PLATE	0.33	13.3		1.45				
		0.33	20		1.01	23.98			
		0.33	25	0.05	4.19	28.69			
		0.8	25	0.42					
T6511	EXTRUSION	0.05	9			13.85	52.37		
		0.5	9		3.07	24.25	176.06		
T73	FORGED BAR	0.1	1			1.81	27.3		
		0.3	1				44.47		
		0.5	1			14.55			

Figure 1.8 Sample Table (pg 8-457): Fatigue Crack Growth Rate at Defined Levels of Stress Intensity (Alloy Summary)

1.5.1 Plane Strain Fracture Toughness Data

The format for the plane-strain fracture toughness data is shown in Figure 1.9. This particular example is taken from the aluminum 7000/8000 chapter for alloy 7075. The data are sorted by condition/heat treatment, product form, test temperature, orientation and yield strength using the primary sort order identified in Section 1.2.1. K_{Ic} data collected for similar test conditions are grouped together with the mean and standard deviation listed in a column near the right of the page. Product thickness is listed after product form, but is not a sorting parameter. Specimen dimensions (thickness and width) and crack length are also listed, but not sorted in any particular order. The $2.5(K_{Ic}/\sigma_{ys})^2$ criterion value is included for information purposes only. Two additional columns list the date of the reference and the reference number so that when and where the data were collected can be assessed, and where additional information might be obtained should it be desired. Footnotes may be given as a number enclosed in parentheses behind the reference number. Footnotes are used to indicate out-of-range conditions, average data values, and other important identifying features.

Reference numbers from the earlier versions of the handbook have been retained and new data have been assigned a new reference number with the first two or three characters identifying the organization or journal from which the data was obtained. Table 1.9 lists the general format for later reference numbers.

1.5.2 Plane Stress Fracture Toughness Data

The format for presenting plane stress fracture toughness (K_c) data is presented in Figure 1.10. Plane stress fracture toughness data within a particular alloy section are ordered by condition/heat treatment, buckling of crack edges (restrained, unrestrained, or unknown), product form, test temperature, specimen orientation, specimen thickness and specimen width. Additionally, initial and final crack lengths are given as a function of the total crack length (2a) for center-cracked

TABLE 8.9.2.1

ALUMINUM 7075 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
T6	Forging	0.50	R.T.	L-T	79.0	1.000	0.500	CT	0.534	0.23	24.20	24.3	0.1	1973	86213
		0.50			79.0	1.000	0.500	CT	0.523	0.24	24.40			1973	86213
T6	Forging	0.89	R.T.	T-L	67.2	0.500	0.249	NB	0.265	0.21	19.70	20.9	1.7	1973	86213
		0.89			70.0	0.500	0.249	NB	0.273	0.25	22.10			1973	86213
T6	Forging	0.50	R.T.	S-L	65.4	1.000	0.499	CT	0.493	0.17	17.00	16.8	0.4	1973	86213
		0.50			65.4	1.000	0.500	CT	0.510	0.16	16.70			1973	86213
		0.50			65.4	1.000	0.500	CT	0.496	0.16	16.40			1973	86213
		0.50			65.4	1.000	0.500	CT	0.505	0.17	17.20			1973	86213
T6	Forging	0.75	82	L-T	69.9	2.000	0.500	CT	1.025	0.44	29.20	...	...	1973	86213
T6	Forging	0.89	82	T-L	57.4	1.500	0.749	CT	0.785	0.32	20.40	19.4	1.7	1973	86213
		0.89			57.4	1.500	0.749	CT	0.762	0.32	20.40			1973	86213
		0.75			67.6	1.000	0.500	CT	0.511	0.17	17.50			1973	86213
T6	Forging	0.89	84	T-L	68.0	1.500	0.750	CT	0.792	0.24	21.20	20.6	0.8	1973	86213
		0.89			68.0	1.500	0.750	CT	0.798	0.22	20.00			1973	86213
T6	Extrusion	2.00	R.T.	T-L	72.0	1.500	0.750	CT	0.797	0.19	20.00	19.9	0.2	1973	86213
		2.00			73.6	1.500	0.749	CT	0.798	0.18	19.70			1973	86213
		2.00			73.6	1.500	0.748	CT	0.791	0.19	20.10			1973	86213
T6	Extrusion	2.00	R.T.	S-L	67.0	1.500	0.748	CT	0.791	0.19	18.50	18.5	0.2	1973	86213
		2.00			67.0	1.500	0.750	CT	0.798	0.19	18.30			1973	86213
		2.00			67.2	1.500	0.749	CT	0.808	0.19	18.70			1973	86213
T6	Forged Bar	...	R.T.	C-L	68.6	1.500	0.750	CT	0.750	0.20	19.60	19.5	0.2	1972	82879
		...			68.6	1.500	0.750	CT	0.750	0.20	19.30			1972	82879

Figure 1.9 Sample Table (pg 8-487): Plane Strain Fracture Toughness Data by Alloy

TABLE 1.9

REFERENCE NUMBER EQUATES TO ORGANIZATIONS AND JOURNALS

Reference Number	Organization or Journal Equate
ALxxx	Alcoa Laboratories - Alcoa Center, PA
ALLxx	Allison Gas Turbine Division, GM, Indianapolis, IN
AMxxx	Airesearch Manufacturing, Los Angeles, CA
BLxxx	Battelle Columbus Laboratories, Columbus, OH
BWxxx	Boeing Military Airplane Co., Wichita, KA
DAxxx	Douglas Aircraft, Long Beach, CA
EFMxx	Journal of Engineering Fracture Mechanics
FRxxx	Fairchild Republic, Farmingdale, NY
GDxxx	General Dynamics, Fort Worth, TX
GExxx	General Electric, Evendale, OH
HDxxx	Westinghouse Hanford Development Lab, Richland, WA
JEMxx	Journal of Engineering Materials and Technology
LGxxx	Lockheed Georgia, Marietta, GA
MAxxx	McDonnell Aircraft Co., St. Louis, MO
MDxxx	McDonnell Douglas Astronautics Corp, Huntington Beach, CA
MRxxx	Materials Research Laboratory, Glenwood, IL
NCxxx	Northrop Corporation, Hawthorne, CA
NHxxx	NASA Houston, Houston, TX
NLxxx	NASA Langley Research Center, Hampton, VA
NRxxx	Naval Research Laboratories, Washington, DC
PWxxx	Pratt & Whitney Aircraft Group, Government Products Division, West Palm Beach, FL
RAxxx	Reynolds Metals Co., Richmond, VA
RIxxx	Rockwell International, North American Division and Shuttle Orbiter Divsion, Los Angeles, CA
SAxxx	Sikorsky Aircraft, Stratford, CN
SWxxx	Southwest Research, San Antonio, TX
UCxxx	University of Cincinnati, Cincinnati, OH
UDxxx	University of Dayton Research Institute, Dayton, OH
UMxxx	University of Missouri, Rolle, MO
UVxxx	University of Virginia
WAxxx	Wright Aeronautical Laboratories, WPAFB, OH
WLxxx	Wright Patterson Materials Laboratory, WPAFB, OH

TABLE 8.9.2.2 (CONTINUED)

ALUMINUM 7075 K_C

CONDITION HEAT TREAT	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	CRACK LENGTH INIT (in.) $2a_o$	CRACK LENGTH FINAL (in.) $2a_c$	GROSS STRESS ONSET (Ksi) σ_o	GROSS STRESS MAX (Ksi) σ_{Max}	K_{app} (Ksi$\sqrt{in}$)	K_{app} MEAN	K_{app} STAN DEV	K_c (Ksi$\sqrt{in}$)	K_c MEAN	K_c STAN DEV	DATE	REFER
BUCKLING OF CRACK EDGES NOT RESTRAINED																			
T6	Sheet	0.06	R.T.	T-L	71.8	3.000	0.061	1.050	---	---	36.50	50.76	50.1	0.8	---	---	---	1973	86213
		0.06			71.8	3.000	0.061	1.120	---	---	34.30	49.85			---			1973	86213
		0.06			71.8	3.000	0.061	1.080	---	---	34.80	49.33			---			1973	86213
		0.06			71.8	3.000	0.061	1.050	---	---	35.50	49.37			---			1973	86213
		0.06			71.8	3.000	0.061	1.060	---	---	35.70	49.97			---			1973	86213
		0.06			75.5	3.030	0.063	0.750	0.770	---	45.50	51.34			52.13*			1966	86734
T6	Sheet	0.12	R.T.	T-L	72.9	3.000	0.123	1.060	1.350	---	31.30	43.53	45.8	2.8	52.27	51.5	2.5	1973	86213
		0.12			72.9	3.000	0.123	1.050	1.380	---	33.90	47.15			57.63*			1973	86213
		0.12			72.9	3.000	0.123	1.110	1.410	---	32.90	47.52			56.93*			1973	86213
		0.12			72.9	3.000	0.123	1.070	1.320	---	32.50	45.78			53.31			1973	86213
		0.12			72.9	3.000	0.123	1.100	1.450	---	34.00	48.80			60.25*			1973	86213
		0.12			72.9	3.000	0.123	1.090	1.380	---	32.60	46.50			55.42*			1973	86213
		0.12			72.9	3.000	0.123	1.130	1.420	---	32.50	47.53			56.57*			1973	86213
		0.12			74.1	3.000	0.123	1.000	1.380	---	35.40	47.68			60.18*			1973	86213
		0.12			74.1	3.000	0.123	1.000	1.250	---	34.50	46.46			54.28			1973	86213
		0.12			74.1	3.000	0.123	1.000	1.240	---	34.10	45.92			53.32			1973	86213
		0.12			74.1	3.000	0.123	1.000	1.360	---	36.70	49.43			61.65*			1973	86213
		0.12			72.9	3.000	0.124	1.100	1.240	---	31.00	44.50			48.48			1973	86213
		0.12			72.9	3.000	0.124	1.120	1.340	---	31.80	46.22			52.79			1973	86213

* NOTE: NET SECTION STRESS EXCEEDS 80% OF YIELD STRENGTH. VALUE NOT INCLUDED IN MEAN OR STANDARD DEVIATION.

Figure 1.10 Sample Table (pg 8-532): Plane Stress and Transitional Fracture Toughness Data by Alloy

panel specimens. Also, the onset and maximum gross stress values are listed when available. The fracture toughness parameters K_c and K_{app} are calculated as described in Chapter 2 and the individual as well as the mean and standard deviation values are listed for both K_c and K_{app}. The final two columns present the date of the reference and the reference number.

1.5.3 R-Curve Data

The format for resistance curve (R-Curve) data is shown in Figure 1.11. The information listed at the top of the page includes alloy, condition/heat treatment, product form, product thickness (if known), specimen design, specimen orientation, specimen dimensions (thickness and width), K_c value (if known), and reference number. Unless otherwise specified, the data were tested at room temperature in laboratory air environments. Only one specimen is illustrated per figure, and the figures are sorted by alloy, condition/heat treatment, test temperature and environment, specimen orientation, specimen thickness, and specimen width. Resistance curve data are plotted on linear axes with applied stress intensity K_R (Ksi$\sqrt{\text{in}}$) as a function of change in effective crack length Δa_{eff} (in.). Section 2.4 contains details associated with the R-curve calculation.

1.6 SUBCRITICAL CRACK GROWTH SUBSECTION FORMATS

The subcritical crack growth data follow the fracture toughness data within each alloy section. The subcritical crack growth data includes: fatigue crack growth rate data, sustained load crack growth rate data, and stress corrosion cracking threshold data. Figures and tables in these sections are labeled *C.A.*3..., where *C* is the material chapter number, *A* is the alloy section number, and "3" indicates subcritical crack growth sections. A fourth number appears on each figure and table. The numbers "1", "2", and "3" in the fourth position indicate fatigue crack growth rate, sustained load crack growth rate, and stress corrosion cracking threshold data, respectively. Both the fatigue and sustained load crack growth rate figures have a fifth number when multiple plot sets exist for an alloy.

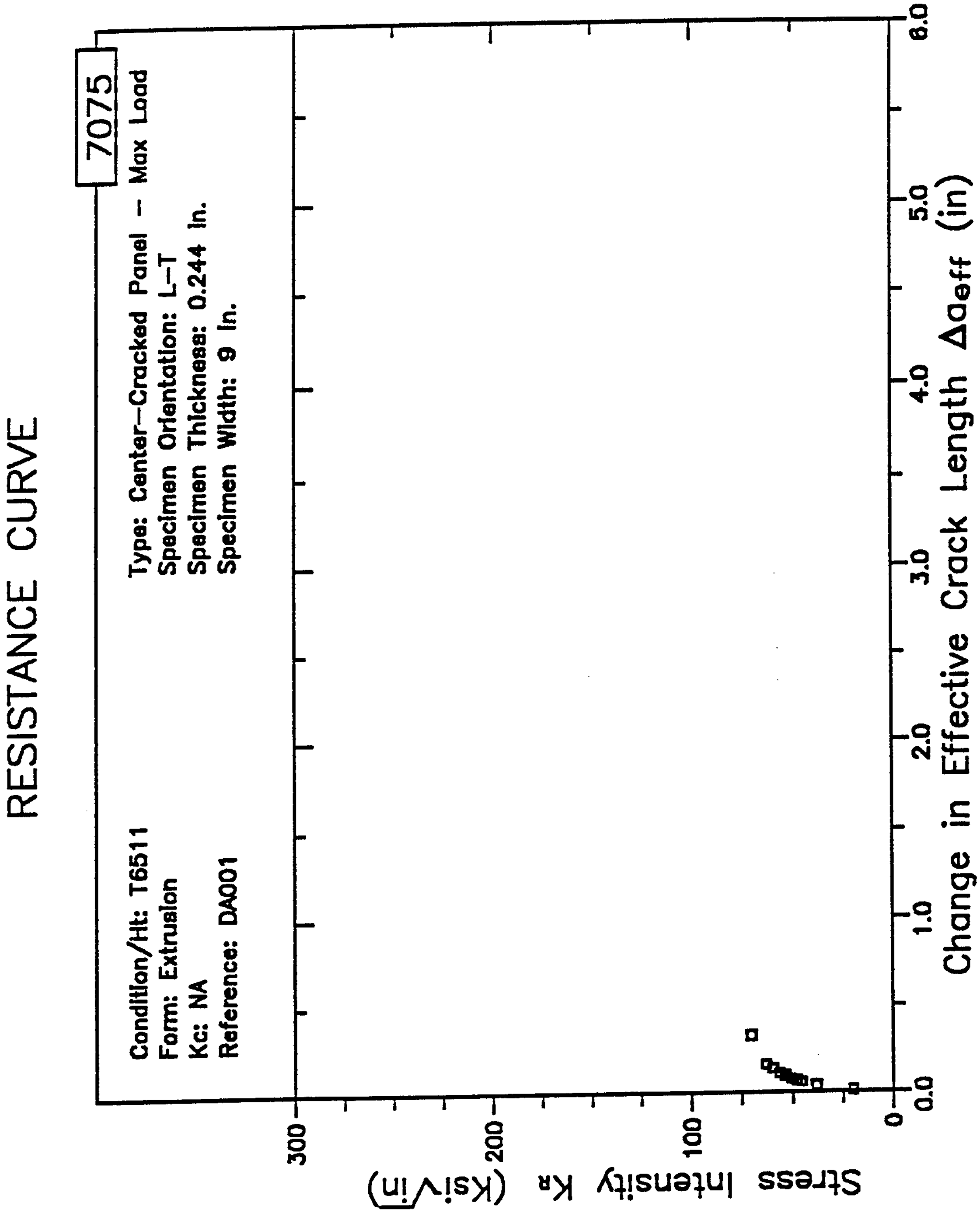


Figure 1.11 Sample Figure (pg 8-554): R-Curve Data by Alloy

1.6.1 Fatigue Crack Growth Rate Data

Fatigue crack growth rate data are presented in two complementary formats: graphical (data points overlaid with a mean trend curve) and tabular (listing of mean trend data points). The data on a page describe the effects of one of three varying parameters - stress ratio, environment/test temperature, or frequency. A header window lists parameter values which are considered constant for all test data being presented. Plots for two values of the varying parameter can be presented on a given page. Multiple pages are used to present plots for three or more values of the varying parameter. In addition to the da/dN-ΔK plots and mean trend tables, minimum and maximum ΔK, root mean square percent error, and life prediction ratio of the mean trend curve are given when available. All plots having similar header data are subsequently referred to as a plot set.

Figure 1.12 shows an actual page of fatigue crack growth rate data from the handbook. Each page consists of five data block types: 1) header block, 2) FCGR plot block, 3) mean trend block, 4) root mean square (RMS) block, and 5) life prediction ratio (LPR) block. The header block is common to the plot set. Data block types 2 through 5 are specific to one value of the varying parameter.

The header block identifies the alloy, the varying parameter, and constant values for all plots in the current plot set. The alloy is identified in the upper outside corner of the plot page. The varying parameter is also identified in the upper outside corner by the presence of the capital letters "R" (stress ratio), "E" (environment), "F" (frequency), or "EF" (combination of environment and frequency). Environment is the varying parameter in Figure 1.12. Condition/heat treat, product form/thickness, specimen type, specimen orientation, tensile yield and ultimate strengths, specimen thickness, specimen width, and references always appear in the header block if available. Stress ratio, environment, and frequency are also listed in the header block when they are not the varying parameter. Values of certain constant parameters are given as ranges when the values are close enough to be considered similar.

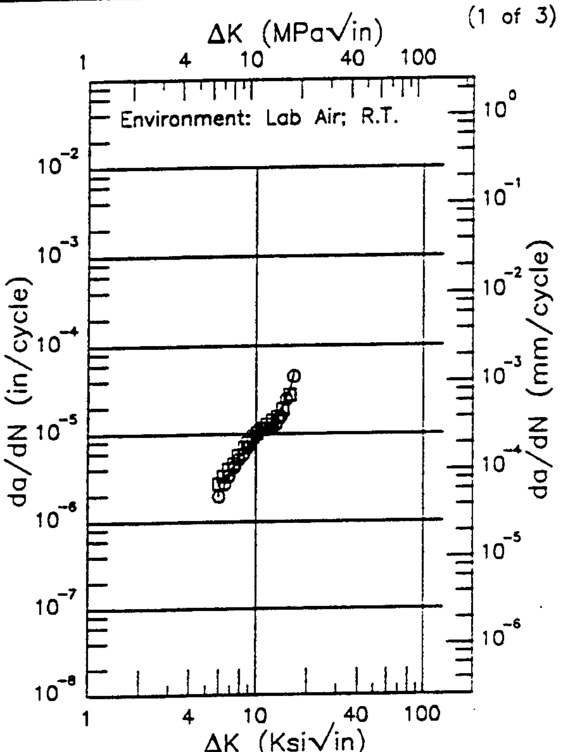
7075

E

Condition/Ht: T7352
Form: 6 in. Forging
Specimen Type: CCP (max load specified)
Orientation: T–S
Stress Ratio: 0.33
Frequency: 5.2 Hz

Yield Strength:
Ult. Strength:
Specimen Thk: 0.73 – 0.75 in.
Specimen Width: 3 in.
Ref: 77720

(1 of 3)



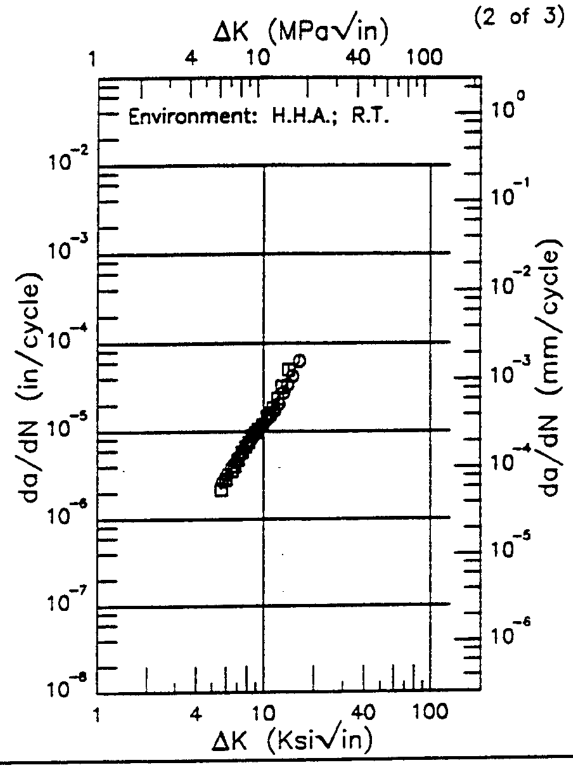
ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
5.97 (min)	2.60
6.	2.63
7.	3.82
8.	5.53
9.	7.61
10.	9.75
13.	14.2
16.	34.2
16.54 (max)	45.6

RMS % Error 9.03

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
5.62 (min)	2.29
6.	2.94
7.	4.85
8.	7.00
9.	9.48
10.	12.5
13.	28.3
16.	57.4
16.40 (max)	62.2

RMS % Error 8.11

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 1.12 **Sample Figure (pg 8-698): Fatigue Crack Growth Rate Plot and Mean Trend Fit**

The FCGR plot block consists of the following four items: 1) a trend plot of da/dN-ΔK data, 2) the value of the varying parameter, 3) a mean trend curve (if available), and 4) the plot set sequence number. Fatigue crack growth rate (da/dN) is plotted as a function of the range of stress intensity (ΔK). The definition of ΔK according to ASTM Standard E647, i.e., $\Delta K = K_{max}$ if stress ratio is negative, was chosen for data presentation throughout the handbook. The logarithmic x-axis represents ΔK and spans from 1 to 200 Ksi$\sqrt{in}$. The logarithmic y-axis represents da/dN and spans 7 decades from 10^{-8} to 10^{-1} inches/cycles. English units, i.e., inches/cycle for da/dN and Ksi$\sqrt{in}$ for ΔK, are listed to the left and bottom of each plot respectively. The corresponding metric units for da/dN and ΔK, i.e., mm/cycle and MPa$\sqrt{m}$, respectively, are placed on the opposite side of the plot as their English counterparts.

The trend plots in Figure 1.12 indicate that multiple plot symbols may be used. Each symbol represents a unique set of test data. Up to eight different tests can be accommodated in a single plot. If more than eight tests have common header data, then additional plots are generated. Each plot uses the same plot symbols; however, the data they represent are independent from plot to plot. If eight or more data points exist, a mean trend curve is fit to the plotted data using a cubic spline polynomial. The cubic spline polynomial fit method is described in Section 2.5.4.

The sort order in which fatigue crack growth rate data are presented is as follows: alloy, condition/heat treat, product form, product thickness, specimen design, and specimen orientation. The ordering by product form has been revised so that similar product forms such as extruded bars/extrusions and forged bars/forgings can be presented next to each other. Table 1.10 presents the revised sort order of product form. Table 1.4 above presents the sort order of specimen design and specimen orientation.

TABLE 1.10

ALTERNATE PRODUCT FORM SORTING ORDER FOR CRACK PROPAGATION DATA

Product Form
Sheet
Plate
Bar
Billet
Disk
Extrusion
Extruded Bar
Forging
Hand Forging
Forged Bar
Rolled Bar
Round Bar
Casting
Weldment

Given that certain test data have similar values for the above mentioned parameters, individual plots in a plot set are presented in order by varying parameter. Plot sets varying stress ratio are placed before plot sets varying environment which in turn are placed before plot sets varying frequency. For varying stress ratio, plots are presented in ascending stress ratio order. When environment is the varying parameter, plots are presented in alphabetical order on environment and ascending test temperature. For varying frequency, plots are presented in ascending frequency order.

The mean trend window presents fatigue crack growth rate values calculated at predefined ΔK levels based on the cubic spline polynomial curve fit to

the test data. Table 1.11 lists the 30 possible ΔK levels for which corresponding da/dN crack growth rates may be calculated. The minimum and maximum ΔK values observed in the test data are included and delimit the range of predefined ΔK levels to be included in a mean trend table. If less than eight data points are available, the mean trend window is empty.

TABLE 1.11

PREDEFINED ΔK LEVELS

1.0	1.3	1.6	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0
10.	13.	16.	20.	25.	30.	35.	40.	50.	60.	70.	80.	90.
100.	130.	160.	200.									

The RMS data block presents root mean square percent error (RMS % Error) which is a description of scatter about the mean trend line; i.e., a smaller value indicates less scatter than a larger value. The RMS block is empty if a mean trend cannot be generated. The calculation of the root mean square percent error is described in Section 2.5.4.

The LPR data block reports the life prediction ratio for specimen test data plotted in the plot block. The LPR is the number of cycles predicted using the mean trend curve divided by the actual number of cycles taken from the experimental crack length versus cycle (a-vs-N) data for a predefined interval. Plot symbols are placed along a scale ranging from zero to two with intermediate tic marks at 0.5, 0.8, and 1.25. The plot symbol placed along the scale is the same plot symbol used to represent a specimen test in the trend plot above. LPR values which fall between 0.8 and 1.25 indicate an adequate mean trend fit. For threshold type tests and for tests in which the loads were varied frequently during the test, LPR values tended to be well outside this range. Some test data shown on the trend plot do not have a calculated LPR value because the data were received in reduced form, i.e., da/dN-vs-ΔK rather than a-vs-N, and therefore had no actual cycle count for comparison. If a mean trend fit cannot be generated, no plot symbols appear in the LPR data block.

1.6.2 Sustained Load Crack Growth Rate

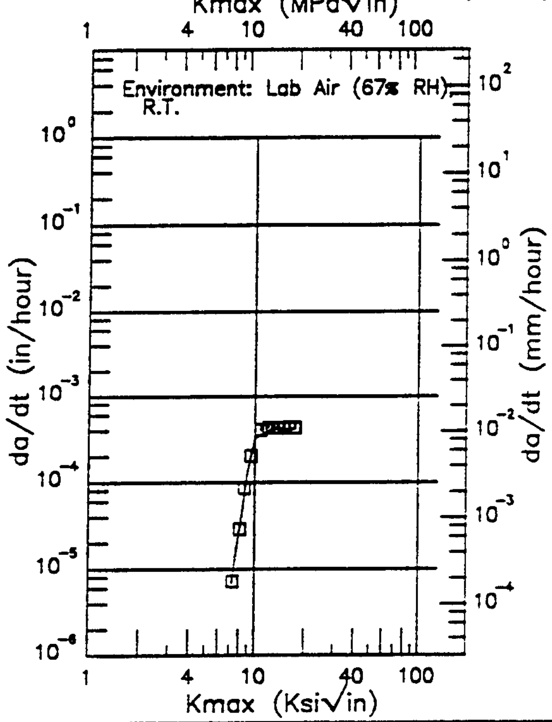
The sustained load crack growth rate data are presented after the fatigue crack growth rate data and are plotted on log-log scales in a manner similar to the FCGR data (See Figure 1.13). The data are plotted to present time based crack growth rate as a function of maximum stress-intensity factor on pages with header blocks and two graphs of equal size with both English and Metric units lining opposite sides of the plot. The alloy is identified in the upper outside corner of the plot page. The condition/heat treatment is listed at the very top of the header block and the remaining parameters are listed in two columns beneath the condition. The first column contains the parameters of product form and thickness, specimen type, specimen orientation, tensile yield strength, and tensile ultimate strength. The second column contains specimen thickness and width, initial crack length (a_0), stress corrosion cracking threshold value K_{Iscc}, and reference numbers. There are also three variations on these plots, that is, variations on product form and product thickness, tensile yield strength, and test temperature/environment. There are also some data sets in which condition/heat treatment for a given alloy is varied. In addition to the three basic plot variations noted, the sustained load crack growth rate data have two possible growth rate axes in order to accommodate the data. Both axes span six decades. The first axis ranges from 10^{-6} to 1 inches/hour, the second 10^{-4} to 10^{2} inches/hour (English units). Both have maximum stress-intensity (K_{max}) values that range from 1 to 200 Ksi$\sqrt{in}$. The corresponding metric units for da/dt and K_{max}, i.e., mm/hour and MPa$\sqrt{m}$, respectively, are placed on the opposite side of the plot as their English counterparts.

Some of these data also have mean trend curves and mean trend tables associated with them. The mean trend tables are presented directly beneath the graphical presentation of the data in a manner similar to the fatigue crack growth rate data. The format of the table in Figure 1.13 is nearly identical to that of the fatigue crack growth rate data. Since all sustained crack growth data were received in reduced form, the LPR cannot be calculated. Therefore, LPR has been omitted

Condition/Ht: T651
Form: 1 in. Plate
Specimen Type: DCB
Orientation: T–L
Yield Strength: 68 ksi
Ult. Strength:

Specimen Thk:
Specimen Width: 11.8 in.
A_0: 3 in.
K_{Iscc}:
Ref: 85543

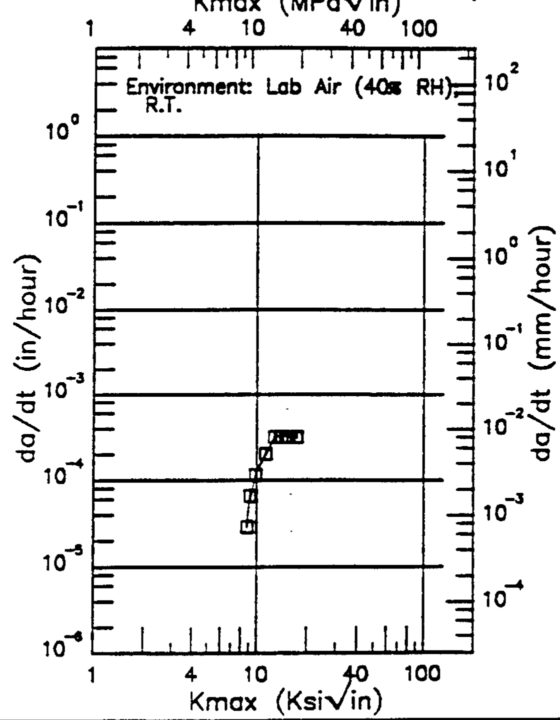
(3 of 8)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
7.30 (min)	0.00691
8.	0.0264
9.	0.130
10.	0.324
13.	0.420
16.	0.405
17.30 (max)	0.425

RMS % Error
10.02

(4 of 8)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
8.70 (min)	0.0301
9.	0.0534
10.	0.128
13.	0.324
16.	0.331
17.30 (max)	0.310

RMS % Error
5.68

Figure 1.13 Sample Figure (pg 8-731): Sustained Load Growth Rate Plot and Mean Trend Fit

from the plot page. Due to the nature of the data, the values of the RMSPE are usually larger than those of the FCGR data. Additionally, mean trend curves representative of the data are not always created. For these cases, no mean trend curve or table is presented.

1.6.3 Stress Corrosion Cracking Threshold

Following the sustained load crack growth rate data is the tabular stress corrosion cracking threshold data. An example of this data format is presented in Figure 1.14, which is similar to the fracture toughness data format. The material, alloy and data type are listed in the table title. Condition/heat treatment, product form, product thickness, test temperature, specimen orientation, yield strength, and environment are listed in the table from left to right. Following these parameters are the specimen design, width and thickness as well as product thickness, crack length, K_Q fracture toughness, K_{Iscc} individual values, test times, dates and reference numbers. The data are sorted by alloy, condition/heat treatment, product form, test temperature, specimen orientation and environment.

The fracture toughness value K_Q indicates the level of crack toughness of the material. These values were obtained from threshold tests and are not valid plane-strain fracture toughness values. The K_Q values, however, should provide an engineer with an indication of stress-corrosion cracking sensitivity relative to fracture.

In the K_{Iscc} tabular data, the specimen design column and/or the K_{Iscc} column may be footnoted. An asterisk appearing in the specimen design column indicates that the specimen has been side-grooved along the path of the crack. A plus sign appearing in the K_{Iscc} column behind the individual K_{Iscc} values indicates that the crack length and/or specimen thickness were not greater than the required minimum value of $2.5(K_{Iscc}/\sigma_{ys})^2$.

TABLE 3.7.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(250)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
Unspecified	P	R.T.	---	252	Synth. Seawater	CANT*	1	1	1	---	72.6	49	30000	1966	65166
				259	Synth. Seawater	CANT*	3	1	1.25	1.05	93	35	60000	1968	73829
						CANT*	0.5	1	1.25	0.17	68	21	60000	1968	73829
						CANT*	1	1	1.25	0.35	78	37	60000	1968	73829
						CANT*	5	1	1.25	1.75	95	38	60000	1968	73829
						---	---	---	---	---	---	36.5	---	1969	74232
1650F 1.25hr WQ; 1525F 1.25hr WQ; 900F 3hr AC	P	R.T.	---	259	Synth. Seawater	CANT*	3	1	1.25	---	93	35	---	1970	78065
						CANT*	1	1	1.25	---	78	37	---	1970	78065
						CANT*	5	1	1.25	---	95	38	---	1970	78065
900F 2hr AC	S	R.T.	---	228	3.5% NaCl	CNT	2	0.05	0.08	---	---	110•	20000	1968	72283
					Dist. Water	CNT	2	0.05	0.08	---	---	110•	30000	1968	72283
Age 900F 3hr	P	R.T.	L-T	249	3.5% NaCl	NB	1.5	0.48	0.48	---	92	45	---	1971	84351
Aged 900F 3hr AC	P	R.T.	L-S	---	3.5% NaCl	CANT*	0.5	0.375	0.5	---	---	50	---	1971	80824
						CANT	0.482	0.375	0.5	---	---	31	---	1971	80824
TYS=250Ksi	P	R.T.	---	250	3.5% NaCl	CANT*	---	1	1	---	70	50	---	1972	83613
TYS=260Ksi	P	R.T.	---	260	3.5% NaCl	CANT*	---	1	1	---	95	70	---	1972	83613

• specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

Figure 1.14 Sample Table (pg 3-66): Stress Corrosion Cracking Threshold Data by Alloy

Greater than (>) and less than (<) signs before the K_{Iscc} value indicate that the actual value is either greater than or less than the value stated, respectively. Data containing these signs were considered to be informative since little data exists and so were included.

Table of Contents

List of Illustrations

Figure **Page**

List of Tables

CHAPTER 2
METHODS OF CALCULATIONS

2.0 OVERVIEW

This chapter briefly describes the methods used to calculate the damage tolerant properties reported in the Handbook. The properties reported for characterizing fracture resistance include:

- K_{Ic}, the plane-strain fracture toughness
- K_c, the critical plane-stress (or transitional) fracture toughness
- K_{App}, the apparent plane-stress fracture toughness
- K_R, the tearing resistance

and, the properties reported for characterizing subcritical crack growth resistance include:

- $\frac{da}{dN}$, the constant amplitude fatigue crack growth rate
- $\frac{da}{dt}$, the sustained-load crack growth rate
- K_{Iscc}, the threshold for sustained load cracking

Sections 2.1 through 2.7 describe these properties and the specific methods of calculations utilized to convert laboratory (specimen) data into the properties reported.

2.0.1 Data Review and Acceptance Criteria

Newly acquired data and data available from previous revisions of the Handbook were systematically reviewed and analyzed. The principal data acceptance

criteria were based on criteria established by the American Society for Testing and Materials (ASTM); these criteria are embedded within ASTM standards for test methods and practices. Table 2.1 lists those standards used to provide criteria for plane-strain fracture toughness (K_{Ic}) data, for R-curve data, and for fatigue crack growth rate (da/dN) data. ASTM literature was also reviewed to establish criteria based on typical engineering practice for the other types of data collected and reported.

TABLE 2.1

APPLICABLE LIST OF STANDARDS FOUND IN THE ASTM BOOK OF STANDARDS

ASTM STD	Title
E616-81	Standard Terminology Relating to Fracture Testing
E399-90	Test Method for Plane-Strain Fracture Toughness of Metallic Materials
E561-86	Practice for R-Curve Determination
E647-91	Test Method for Constant-Load-Amplitude Fatigue Crack Growth Rates Above 10^{-8} m/Cycle

Newly acquired data was substantially easier to process than the data available from previous revisions since the data suppliers screened their data according to ASTM criteria before it was released to the data processing organization (UDRI). Also, when questions concerning newly acquired data developed, the suppliers could be called and the questions resolved.

The final step in the review process was the determination of whether the data were a "true" representation of the behavior they described. This step was implemented for both newly acquired data as well as for the available Handbook data in order to eliminate suspect data through subjective criteria. Unfortunately, it is not possible to detail the subjective criteria that were employed to exclude questionable data. It can be stated that the principal mode of operation here was by way of comparison between behaviors that were expected to be somewhat similar.

2.0.2 Fracture Mechanics Basis

The damage tolerant data reported in this Handbook utilize the technology of linear elastic fracture mechanics. This technology is widely applied throughout the aerospace industry to relate structural calculations for cracked structures to material behavior in the presence of cracks. In essence, fracture mechanics provides a structural parameter, the stress-intensity factor (symbol K) which characterizes the magnitude of stresses and strains in the crack tip region of essentially elastic structures. It was postulated that the stress-intensity factor represents a similitude parameter that describes crack tip behavior under various loading conditions (monotonically increasing load, fatigue loading, etc.); the hypothesis has been verified for a wide number of materials, loading conditions, and failure type mechanisms. For a more thorough review of linear elastic fracture mechanics and its applications to the aerospace industry, see AFWAL-TR-82-3073, USAF Damage Tolerant Design Handbook: Guidelines for the Analysis and Design of Damage Tolerant Aircraft Structures.

Currently, there are developments that are extending the technology of fracture mechanics to aid in the solution of crack problems for which the assumptions of linear elastic fracture mechanics are invalid. This technology is referred to as nonlinear fracture mechanics and its similitude parameter is the J-integral (J), or alternately the crack tip opening displacement (δ). To date, nonlinear fracture mechanics has been successfully utilized to characterize tearing type fractures and fractures occurring in the presence of large-scale yielding. Some evidence has been presented suggesting that J may provide a similitude parameter for non-monotonically increasing type loadings, i.e., for fatigue loadings; but, questions still exist here. It is expected that subsequent revisions of this Handbook will include nonlinear fracture mechanics type data such as J_{Ic}, a plane-strain fracture toughness property, and J_R-curves, (tearing resistance curves).

2.0.3 Test Specimen Geometries

As described above, the stress-intensity factor provides a parameter that can be used to establish similitude between two cracked structures. This means that if the stress intensity factor in structure A equals the stress-intensity factor in structure B and if other conditions (loading, material, environment, etc.) are the same, then the cracks in both structures will behave the same way. This concept provides the justification for conducting material behavior studies on small laboratory test specimens (coupons) which contain cracks. If the resistance to cracking in the laboratory can be optimized by a choice of material, then improved resistance can also be obtained for structural hardware (given that the material can be fabricated into the hardware without processing degradation taking place).

The types of test specimen geometries that have been employed to generate damage tolerance (fracture mechanics) type data for this Handbook are summarized in Table 2.2. Table 2.2 also guides the reader to individual figures (Figures 2.1 through 2.14) which describe the geometries associated with individual specimen names and symbols.

TABLE 2.2

CORRELATION LISTING OF TEST SPECIMEN SYMBOL, TEST SPECIMEN GEOMETRY, AND REFERENCE FIGURE NUMBER

Symbol	Test Specimen	Geometry Described in Figure Number
CCP	Center Crack Panel	2.1
CT	Compact (Tension)	2.2
NB	Three Point Notched Bend	2.3
4-NB	Four Point Notched Bend	2.4
CANT	Cantilever Beam	2.5
WOL	Wedge Opening Load	2.6
BWOL	Bolt Loaded WOL	2.7
SENT	Single Edge Notch Tension	2.8
PTSC	Part-Through Surface Crack	2.9
KB-BAR	K_B BAR	2.10
DCB	Double Cantilever Beam	2.11
BDCB	Bolt Loaded DCB	2.12
TDCB	Tapered Double Cantilever Beam	2.13
CNT	Center Notch Tension	2.14

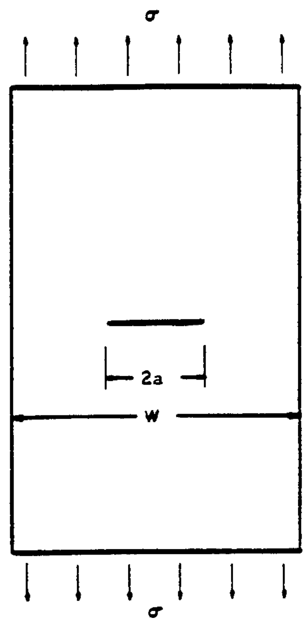


Figure 2.1 Center Cracked Panel (CCP) Specimen.

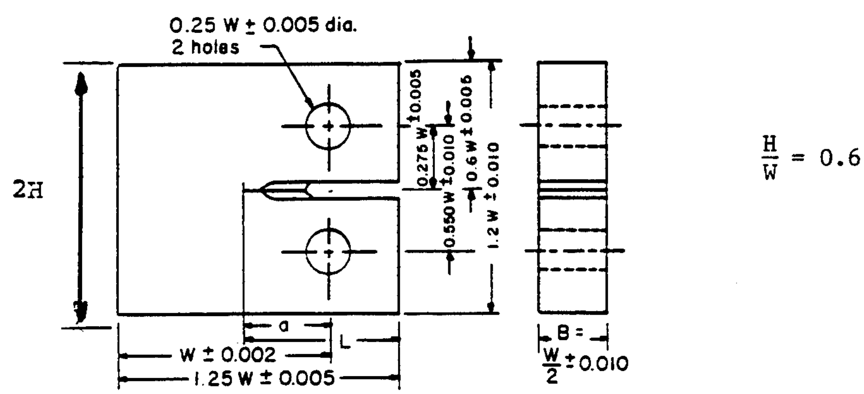


Figure 2.2 Compact Tension (CT) Specimen.

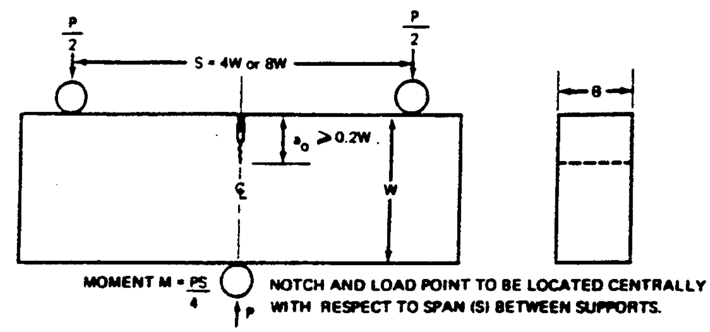


Figure 2.3 Three Point Notched Bend (NB) Specimen.

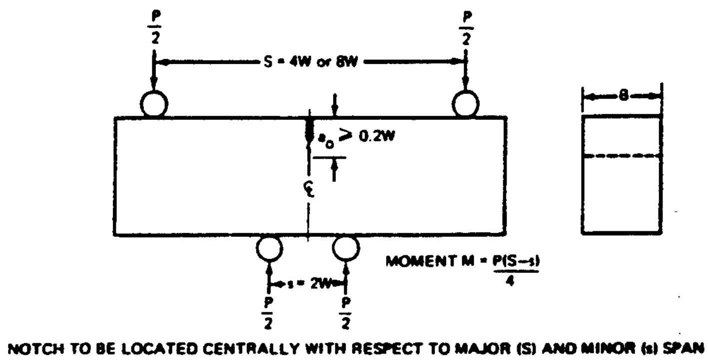


Figure 2.4 Four Point Notched Bend (4-NB) Specimen.

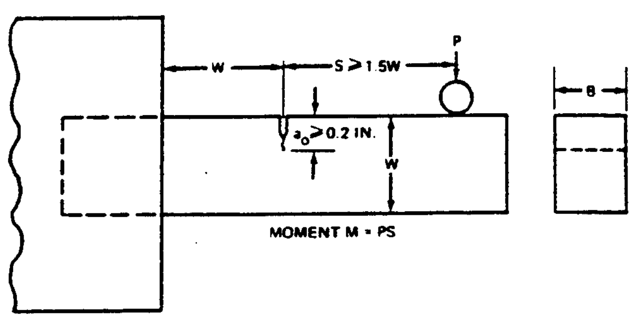


Figure 2.5 Cantilever Beam (CANT) Specimen.

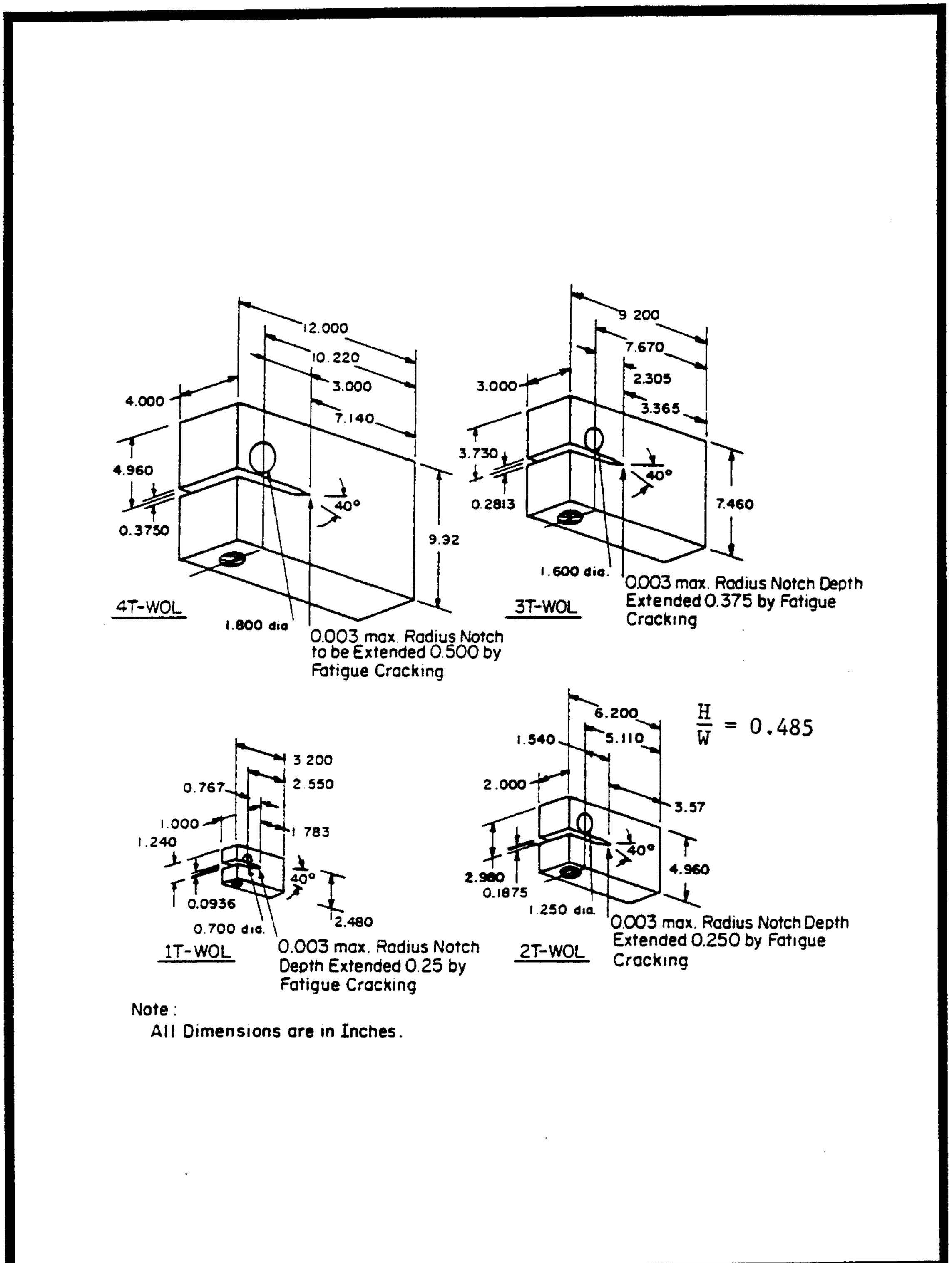


Figure 2.6 Dimensions of Several T Type Wedge Opening Load (WOL) Specimens.

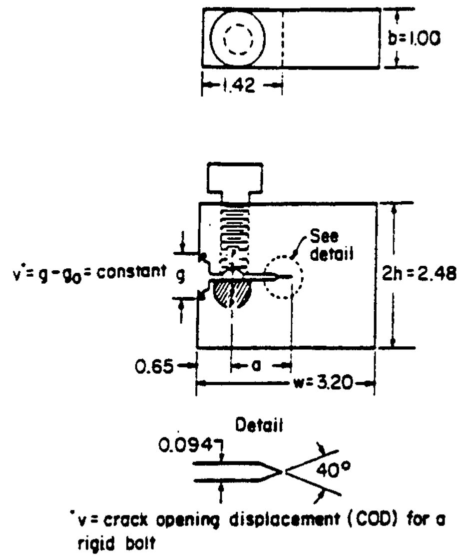


Figure 2.7 Modified 1-T WOL (BWOL) Specimen used to Determine K_{Iscc} by Bolt Loading.

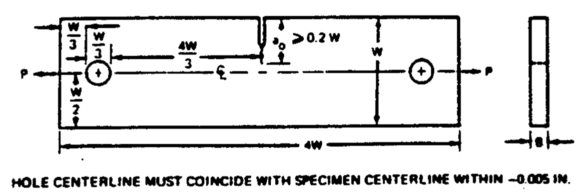


Figure 2.8 Single Edge Notch Tensile (SENT) Specimen.

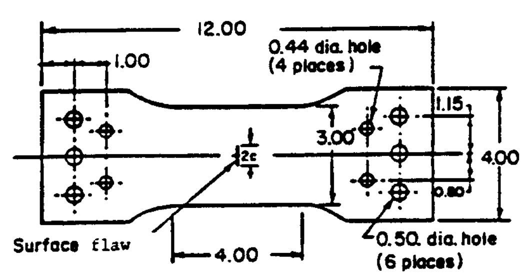


Figure 2.9 Typical Design for Part-Through-Surface-Crack (PTSC) Specimen.

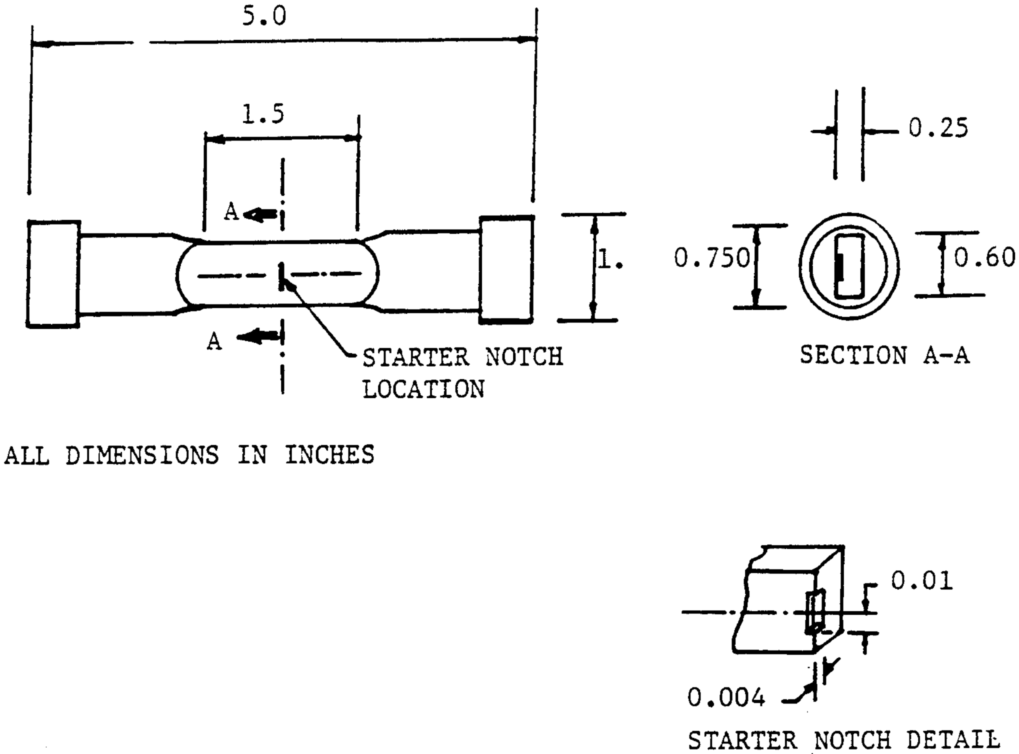


Figure 2.10 K_B Bar (KB-BAR) Specimen.

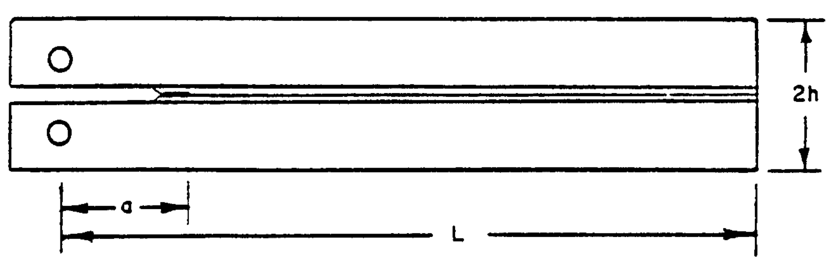


Figure 2.11 Double Cantilever Beam (DCB) Specimen with Side Grooves.

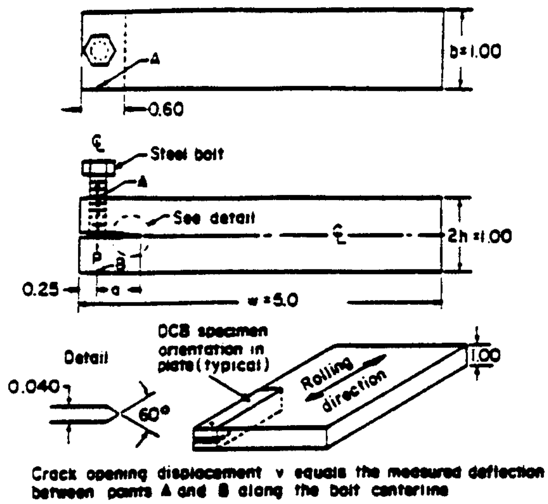


Figure 2.12 Bolt-Loaded Double Cantilever Beam (BDCB) Specimen.

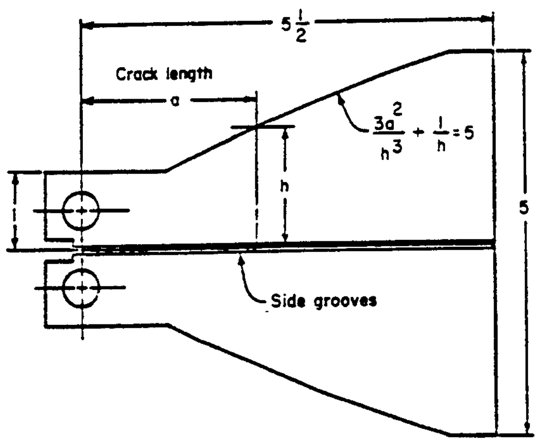


Figure 2.13 Typical Tapered Double Cantilever Beam (TDCB) Specimen with Side Grooves.

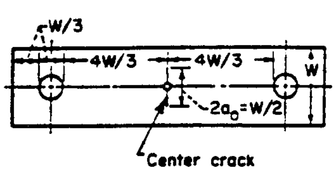


Figure 2.14 Center-Notched Tensile (CNT) Specimen.

To relate the crack type data collected in a cracked test specimen to other cracked structures, it is necessary to have a description of the stress-intensity factor (K) as a function of crack length (a) for the test specimen geometry. A great deal of attention has been given to generating accurate stress-intensity factor equations for laboratory test specimen geometries, due to their importance to standard methods of test and to reporting data. The stress-intensity factor equations are typically presented in either of the following two forms:

$$K = \sigma \sqrt{\pi a} \cdot \beta \tag{2.1}$$

where σ = remote stress (load ÷ area)

a = crack length measure

β = function of crack length and global geometry

or

$$K = \frac{P}{B\sqrt{W}} \; Y \tag{2.2}$$

where P = load

B = thickness of specimen

W = width of specimen

Y = function of crack length (a) and global geometry

Equation 2.1 is used when the loading is applied remotely from the crack, whereas Equation 2.2 is more typically used for point loading or localized loading conditions. One should note that K is a linear function of loading (σ in Equation 2.1 and P in Equation 2.2) and that the loading and geometric components of the equations are independent of each other. Thus, if one wishes to describe a stress-intensity factor relationship for a given geometry, they might formulate the equations in the following forms:

$$\frac{K}{\sigma} = \sqrt{\pi a} \cdot \beta \tag{2.3}$$

or

$$\frac{K}{\frac{P}{B\sqrt{W}}} = Y \tag{2.4}$$

Equations 2.3 and 2.4 are referred to as stress-intensity factor coefficients; the right hand side of these equations only describes the effect of the crack in the given geometry.

Table 2.3 provides a listing of stress-intensity factor coefficients which were used to generate data for this Handbook. Each equation is given a stress-intensity factor equation number, e.g., SIF.7 refers to the stress-intensity factor coefficient for the WOL (Wedge Opening Load) specimen geometry illustrated in Figure 2.6. Also note that Table 2.3 has a remarks section which describes the conditions under which individual equations were used.

2.1 PLANE-STRAIN FRACTURE TOUGHNESS (K_{Ic})

The plane-strain fracture toughness (K_{Ic}) property was initially established to characterize the fracture resistance of materials that exhibited rather abrupt fractures in the presence of cracks. Early observations showed that thickness had a pronounced effect on the critical levels of stress-intensity factor associated with fracture; a schematic illustrating this behavior is presented in Figure 2.15. As noted in the schematic, for thicknesses greater than the experimentally determined lower-bound, the critical stress-intensity factor level was found to be relatively constant.

The reasons for the independence of toughness with further increases in thickness were related to the amount and type of yielding which could occur at the crack tip under what has been referred to as plane-strain conditions. Because the thickness-independent toughness property was useful for comparing a large variety of metals for fracture resistance, ASTM (American Society for Testing and Materials)

TABLE 2.3

STRESS-INTENSITY FACTOR COEFFICIENTS FOR TEST SPECIMEN GEOMETRIES USED TO GENERATE DAMAGE TOLERANT DATA

Test Specimen Geometry	Stress-Intensity Factor Coefficient	Equation Number	Remarks
CCP (See Figure 2.1)	$\frac{K}{\sigma} = \sqrt{\pi a} \cdot (\sec \pi\alpha)^{1/2}$ $\alpha = a/W$	SIF.1	This equation was used whenever K was calculated for the CCP specimen.
CT (See Figure 2.2)	$\frac{K}{\left(\frac{P}{BW^{1/2}}\right)} = \frac{(2+\alpha)}{(1-\alpha)^{3/2}} \cdot \begin{bmatrix} 0.866 + 4.64\alpha - 13.32\alpha^2 \\ +14.72\alpha^3 - 5.6\alpha^4 \end{bmatrix}$ $\alpha = a/W$ $\frac{H}{W} = 0.600$	SIF.2	This equation was used whenever K was calculated for the CT specimen; the equation is considered to be accurate for a/W > 0.2.
CT (See Figure 2.2)	$\frac{K}{\left(\frac{P}{BW^{1/2}}\right)} = \alpha^{1/2} \begin{bmatrix} 29.6 - 185.5\alpha + 655.7\alpha^2 \\ -1017\alpha^3 + 638.9\alpha^4 \end{bmatrix}$ $\alpha = a/W$ $\frac{H}{W} = 0.600$	SIF.3	This equation was only used to calculate K for data directly incorporated into pre-1983 revisions.
NB (3 PT BEND) (See Figure 2.3)	$\frac{K}{\left(\frac{P}{BW^{3/2}}\right)} = S3\alpha^{1/2} \frac{\left[1.99 - \alpha(1-\alpha)(2.15 - 3.93\alpha + 2.7\alpha^2)\right]}{2(1+2\alpha)(1-\alpha)^{3/2}}$ $\alpha = a/W$ $S =$ span length	SIF.4	This equation was used to process all new and pre-1993 revision data for NB specimens.

TABLE 2.3 (Cont'd)

STRESS-INTENSITY FACTOR COEFFICIENTS FOR TEST SPECIMEN GEOMETRIES USED TO GENERATE DAMAGE TOLERANT DATA

Test Specimen Geometry	Stress-Intensity Factor Coefficient	Equation Number	Remarks
4-NB (4 PT BEND) (See Figure 2.4)	$\frac{K}{\left(\frac{6M}{BW^{3/2}}\right)} = \alpha^{1/2}\left[\begin{array}{l}1.99 - 2.47\alpha + 12.97\alpha^2 \\ - 23.17\alpha^3 + 24.80\alpha^4\end{array}\right]$ $\alpha = a / W$ $M = P(S - s) / 4$, moment S, s = major and minor span	SIF.5	No new data were processed from 4-NB specimens. Data incorporated into pre-1983 handbook revisions utilized this equation. s/W must be greater than 2.
CANT (See Figure 2.5)	$\frac{K}{\left(\frac{M}{BW^{3/2}}\right)} = 4.12\left[(1-\alpha)^{1/3} - (1-\alpha)^3\right]^{1/2}$ $\alpha = a / W$ $M = P \cdot S$, moment	SIF.6	No new data were processed from CANT specimens. Data incorporated into pre-1983 handbook revisions utilized this equation.
WOL (See Figure 2.6)	$\frac{K}{\left(\frac{P}{BW^{1/2}}\right)} = \frac{(2+\alpha)}{(1-\alpha)^{3/2}}\left[\begin{array}{l}0.8072 + 8.858\alpha - 30.23\alpha^2 \\ + 41.088\alpha^3 - 24.15\alpha^4 + 4.951\alpha^5\end{array}\right]$ $\alpha = a / W$ $\frac{H}{W} = 0.485$	SIF.7	This equation was used to process all new and pre-1983 revision data for WOL specimens with H/W=0.485. WOL specimens with H/W=0.6 utilized equation SIF.2.
BWOL (See Figure 2.7)	$\frac{K}{\left(\frac{P}{BW^{1/2}}\right)} = \alpha^{3/2}\left[\begin{array}{l}30.96 - 195.8\alpha + 730.6\alpha^2 \\ - 1186.3\alpha^3 + 754.6\alpha^4\end{array}\right]$ $\alpha = a / W$ $B = \sqrt{B \cdot B_N}$ B_N = Net Thickness at Side Groove	SIF.8	This equation was used to calculate stress-intensity factors for both WOL and BWOL in pre-1983 revisions. No new BWOL raw data were received for processing.

TABLE 2.3 (Cont'd)

STRESS-INTENSITY FACTOR COEFFICIENTS FOR TEST SPECIMEN GEOMETRIES USED TO GENERATE DAMAGE TOLERANT DATA

Test Specimen Geometry	Stress-Intensity Factor Coefficient	Equation Number	Remarks
DCB (See Figure 2.11)	$\frac{K}{\left(\frac{P}{BW^{1/2}}\right)} = \alpha^{1/2}\, Y$ $\alpha = a/W$ $Y = Y(a/W, H/W)$ $B = \sqrt{B \cdot B_N}$ B_N = Net Thickness at Side Groove	SIF.12	This specimen was used for generating da/dN, da/dt, and K_{Iscc} data in pre-1983 revisions. The function Y was specified for given H/W. Data collected with DCB specimens were not reprocessed and no new data were received.
BDCB (See Figure 2.12)	$K = \frac{VEh\left[3h(a+0.6h)^2 + h^3\right]^{1/2}}{4\left[(a+0.6h)^3 + h^2 a\right]}$ V = displacement h = height E = Elastic Modulus	SIF.13	This equation was used for K_{Iscc} testing. Data previously calculated using this equation were directly incorporated into the 1993 revision; no new data were received.
TDCB (See Figure 2.13)	$\frac{K}{P} = \left[\frac{E\left(\frac{dC}{da}\right)}{2B_N(1-\nu^2)}\right]^{1/2}$ where $\frac{dC}{da} = \left[3.63 - 0.925\left(0.8 - \frac{B_N}{B}\right)\right] \cdot 10^{-6}$ = Compliance Derivative (lb^{-1}) B_N = Net Thickness at Side Groove E = Elastic Modulus ν = Poisson's Ratio	SIF.14	This equation was used by McDonnell Aircraft Company to reduce data referenced in Ref. No. 84360 (Equation is based on Plane-Strain Assumptions). Data were incorporated without change into the 1993 revision and no new data were received.

TABLE 2.3 (Cont'd)

STRESS-INTENSITY FACTOR COEFFICIENTS FOR TEST SPECIMEN GEOMETRIES USED TO GENERATE DAMAGE TOLERANT DATA

Test Specimen Geometry	Stress-Intensity Factor Coefficient	Equation Number	Remarks
SENT (See Figure 2.8)	$\frac{K}{\left(\frac{P}{WB}\right)} = \sqrt{\pi a}\,\left(1.12 - 0.23\alpha + 10.55\alpha^2 - 21.71\alpha^3 + 30.38\alpha^4\right)$ $\alpha = a / W$	SIF.9	This equation was used to process all new and pre-1993 revision data for SENT specimens.
PTSC (See Figure 2.9)	$\frac{K}{\sigma} = 1.1\left[\frac{\pi a}{Q}\right]^{1/2}$ where for $(a/c) \le 1$; $Q = 1.0 + 1.464\left(\frac{a}{c}\right)^{1.65}$ and for $(a/c) > 1$; $Q = 1.0 + 1.464\left(\frac{c}{a}\right)^{1.65}$ $a =$ depth $2c =$ surface length	SIF.10	This equation was used to process all new and pre-1993 revision data for PTSC specimens.
KB BAR (See Figure 2.10)	This equation was used by Aircraft Engine Group of General Electric Company. Closely approximates Newman and Raju Solution presented in AFWAL-TR-82-3073.	SIF.11	This equation was used for da/dN testing. Previously existing data were directly incorporated into the 1993 revision for this geometry; no new data were received.

TABLE 2.3 (Concluded)

STRESS-INTENSITY FACTOR COEFFICIENTS FOR TEST SPECIMEN GEOMETRIES USED TO GENERATE DAMAGE TOLERANT DATA

TEST SPECIMEN GEOMETRY	STRESS-INTENSITY FACTOR COEFFICIENT	EQUATION NUMBER	REMARKS
TDCB (See Figure 2.13)	$\frac{K}{P}=\left[\frac{E}{2B}\frac{dC}{da}\right]^{1/2}$ where $\frac{dC}{da}=$ constant E = Elastic Modulus $B=\sqrt{B\cdot B_N}$ B_N = Net Thickness at Side Groove	SIF.15	No new data were processed from TDCB specimens. Data incorporated into pre-1983 handbook revisions utilized this equation.
CNT (See Figure 2.14)	$\frac{K}{\sigma}=\sqrt{\pi a}\cdot\left[1-0.2\alpha+4\alpha^2\right]$ $\alpha=a/W$ SIF.16 is comparable to SIF.1 For $0\le\alpha\le0.3$	SIF.16	No new data were processed from CNT specimens. Data (K_{Iscc}) for sheet materials incorporated into pre-1983 handbook revisions utilized this equation.

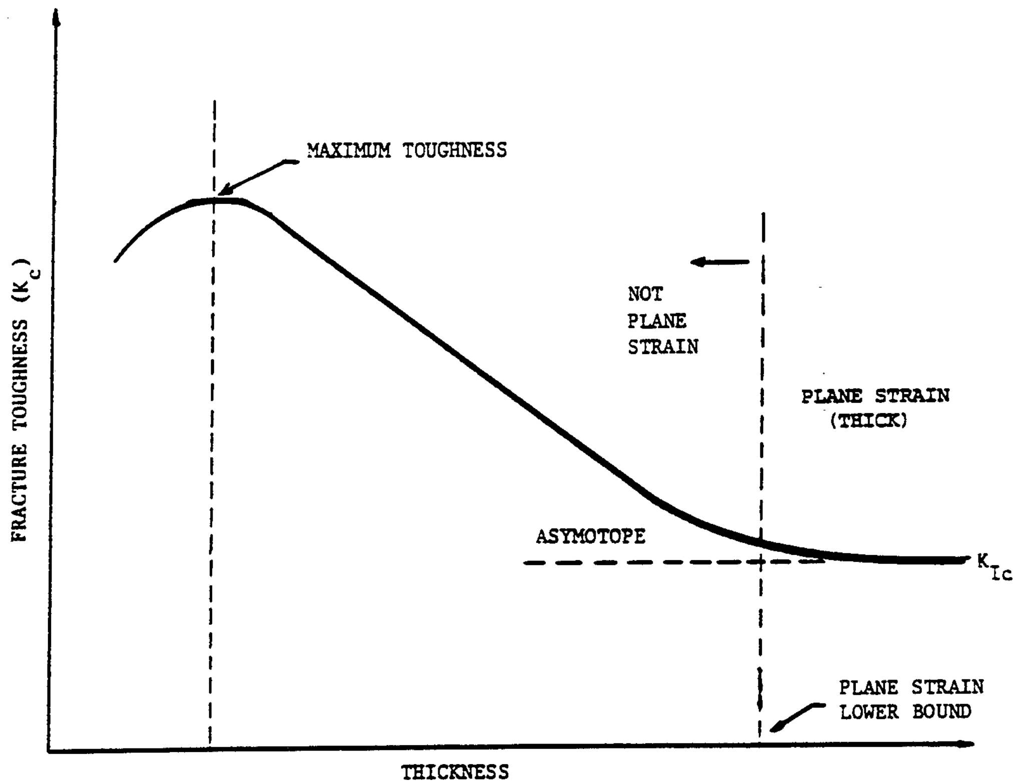


Figure 2.15 Fracture Toughness Behavior as a Function of Thickness.

embarked on a standardization effort that eventually resulted in the ASTM Standard Test Method for plane-strain fracture toughness of metallic materials, i.e., in the ASTM Standard E399.

The ASTM Standard E399 is the current procedure for determining critical plane-strain stress intensity factors (K_{Ic} values) for high-strength alloys. From the method of test, "The property K_{Ic} determined by this method characterizes the resistance of a material to fracture in a neutral environment in the presence of a sharp crack under severe tensile constraint, such that the state of stress near the crack front approaches tritensile plane-strain, and the crack-tip plastic region is small compared with the crack size and specimen dimensions in the constraint direction."

Assuming that plane-strain conditions are approximated when unstable cracking occurs at the crack front during a K_{Ic} test, the critical stress intensity factor calculated from the test data is characteristic of the material of the specimen at the testing temperature and for the specific crack growth direction. Since the properties vary somewhat from specimen to specimen in one plate or in one heat, and from heat to heat of a given alloy type with the same heat treatment, the measured K_{Ic} values for several heats will show some degree of scattering in the data. Usually, the extent of scattering is greater than that for replicate tensile tests. For this reason, a relatively large number of data points would be required to establish minimum design values for any of the fracture mechanics parameters. To minimize the scatter in data, maximum effort is required in controlling the processing, preparation, and testing of each specimen. These precautions are discussed in the Method of Test (ASTM E399).

The ASTM E399 procedure indicates that calculated K values be designated K_Q, which is a provisional value. When the validity of the results is established by the procedures designated in the Method of Test, then the K_Q value can be identified as a valid K_{Ic} value. Some of the primary criteria for judging the validity of K_{Ic} values are based on crack length and specimen thickness conditions. The test data

must demonstrate that sufficient constraint was available to justify the plane strain assumptions. The other requirements for validity of the K_{Ic} values involve measurements of the length of the fatigue crack, contour of the crack front, out-of-plane deviation of the fatigue crack, maximum stress intensity resulting from the fatigue cracking load, and details of the load-deformation curves.

All newly acquired plane-strain fracture toughness (K_{Ic}) data incorporated in the 1993 Handbook revision were generated using the ASTM Standard E399. All suppliers of new K_{Ic} data provided only E399 validated K_{Ic} data in a reduced format which facilitated direct incorporation into the Handbook. Data incorporated in earlier revisions for the most part utilized ASTM Standard E399 or the predecessor tentative method for plane-strain fracture toughness testing; and after review, these data were also included into the 1993 revision. In some instances, nonstandard specimens were used for generating critical plane-strain stress-intensity factors in the earlier revisions. Some of these data were incorporated in the 1993 revision on the basis that a reasonable procedure was used and that corresponding data from other sources were limited for the alloys concerned. All data were checked against the criteria for specimen thickness (B) and crack length (a), i.e., B, a > 2.5 $(K_{Ic}/\sigma_{ys})^2$ where σ_{ys} is the tensile yield strength.

2.2 CRITICAL PLANE STRESS FRACTURE TOUGHNESS

2.2.1 Plane Stress and Transitional Fracture Toughness

The critical level of the stress-intensity factor for non-plane-strain conditions is normally described with the symbol K_c, see Figure 2.15, and is referred to as the plane-stress or transitional fracture toughness. Generally, plane-stress fracture-toughness testing is representative only of through-the-thickness cracks in relatively thin section materials. For a given material thickness, this configuration has the least lateral restraint on the crack front and, hence, approaches most closely the ideal plane-stress stress state conditions at the crack tip. As the material

thickness increases, transitional stress state behavior is introduced by the restraint of additional material along the crack front. In contrast to that in plane-strain fracture-toughness testing, the characterization of fracture toughness in the plane-stress and transitional-stress states is complicated by the degree to which crack tip plasticity and associated stable crack extension are manifested prior to fracture. Although an explicit test method for this mode of toughness has not been formulated, there are a number of useful experimental guidelines which have been developed.

As background information, the nature of plane-stress and transitional fracture toughness is described here in terms of its deviation from that of the plane-strain stress state. Current procedures for this mode of testing and the associated analytical formulations of toughness then are presented.

The difficulties that beset the characterization of plane stress and transitional fracture are not only of a theoretical nature, but also of a practical experimental nature. Basic questions on the nature of plasticity, crack extension, and crack instability, as well as the wide variation in experimental techniques among laboratories all contribute to variability in the resulting fracture toughness evaluations. However, in spite of these difficulties, surprisingly consistent charcterizations of fracture behavior can be obtained.

During the fracture test of a structural material in a plane-stress or transitional-stress state, stable extension of the initial fatigue precrack may occur as the load increases. This behavior is illustrated schematically in the crack growth curve of Figure 2.16. Depending on the material, stable crack extension may amount to 30 percent or more of the initial precrack length.

Once it is understood that fracture under these conditions is not an abrupt instability instantaneously associated with a small increment of crack extension, it must also be recognized that a single toughness parameter is not sufficient to characterize this complex behavior. In fact, the concept of crack growth resistance

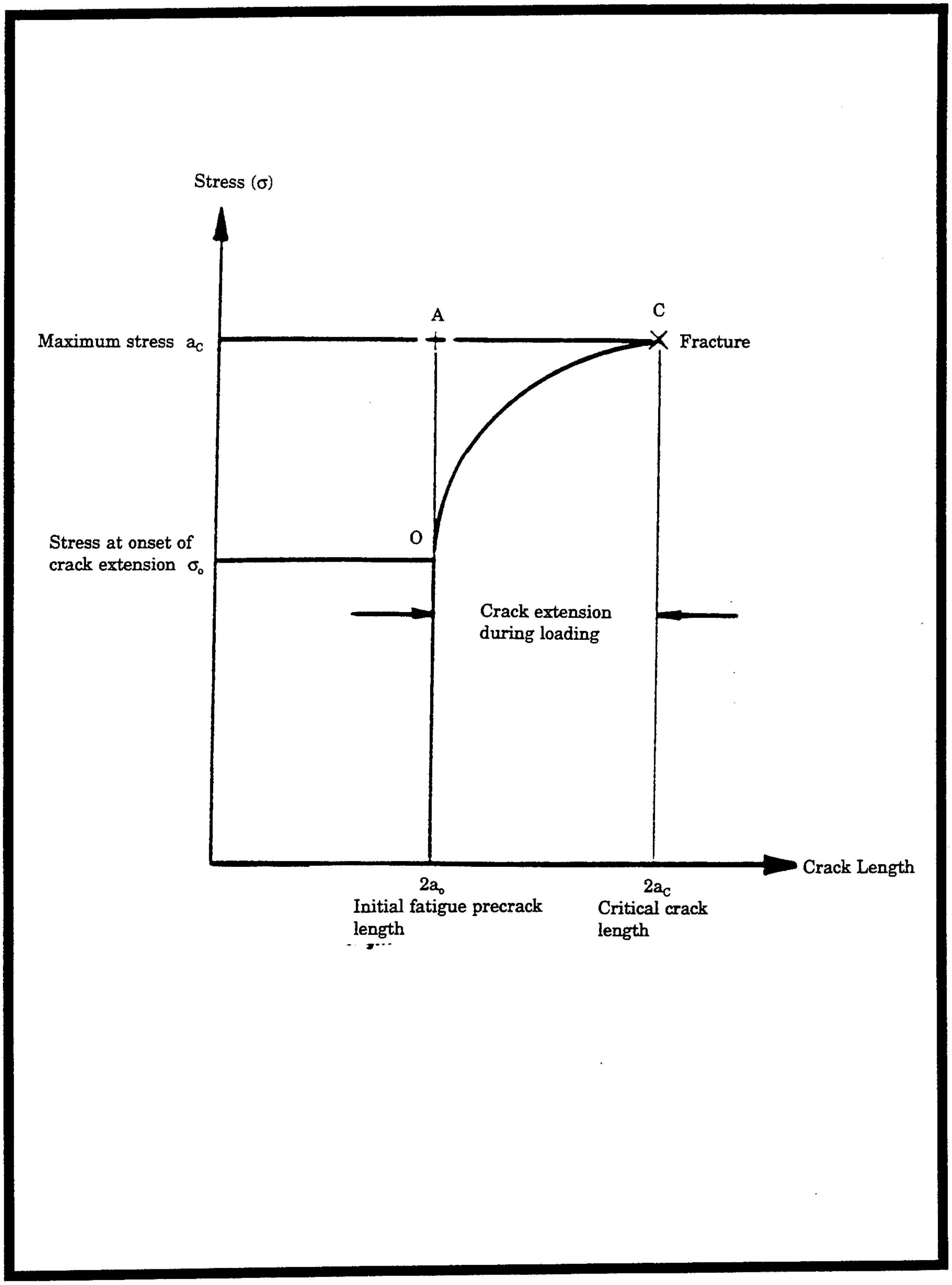


Figure 2.16 Typical Crack Growth Behavior in Plane Stress and Transitional Stress States.

curves (see Section 2.4) is an outgrowth of these observations and best describes the material behavior. However, as a means of characterizing fracture behavior in plane-stress and transitional stress state, engineers have traditionally utilized abrupt fracture concepts, i.e., have used critical stress-intensity factor levels, to describe various events associated with the observed behavior.

2.2.2 Plane Stress and Transitional Fracture Toughness Testing

The procedures associated with testing thin-section center-cracked tension panels differ from those associated with plane-strain fracture toughness testing only in the additional emphasis and refinement that is directed to monitoring the slow, stable tear portion of the fracture process.

The general testing configuration is illustrated schematically in Figure 2.17. The specimen with an initial fatigue precrack, $2a_0$, is loaded slowly under load or stroke control. The onset and extension of crack growth under increasing load is usually monitored photographically, visually, or by means of compliance gage calibration until fracture occurs.

Although, as previously mentioned, more attention is currently being directed to monitoring the detail stress and crack length dimensions during the slow tear process, the majority of available test data is limited to a record of σ_0 or $2a_0$ or σ_c, and $2a_c$, as indicated in Figure 2.16. It is this information which is compiled and analyzed in this Handbook.

2.2.3 Critical Stress-Intensity Factor (K_c)

There are two clearly identified points that can be noted on the crack growth resistance curve shown in Figure 2.16, i.e., points O and C which are associ-

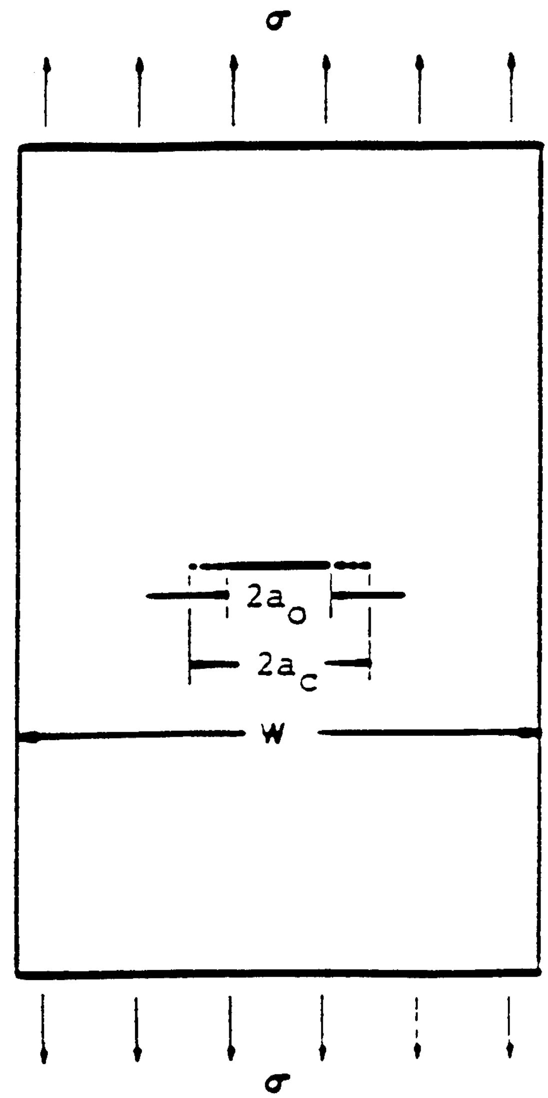


Figure 2.17 Thin-Section, Center-Cracked Tension Panel Configuration.

ated with the onset of tearing and critical conditions, respectively. Using a linear elastic fracture mechanics analysis, these two structural conditions can be formulated as

$$K_{ONSET} = \sigma_o \sqrt{\pi a_o} \left(Sec \frac{\pi a_o}{W} \right)^{\frac{1}{2}} \tag{2.5}$$

and

$$K_c = \sigma_C \sqrt{\pi a_c} \left(Sec \frac{\pi a_c}{W} \right)^{\frac{1}{2}} \tag{2.6}$$

using the stress-intensity factor information given in Table 2.3, i.e., Equation SIF.1. As requested by industry engineers, available test information (σ_o, $2a_o$, σ_c, $2a_c$) were reported in the plane stress and transitional fracture toughness tables along with a calculation of the critical fracture toughness level based on Equation 2.6. While stress and crack length information were sometimes available for a calculation of the onset fracture toughness (Equation 2.5), insufficient space in the table precluded reporting this toughness.

Plane stress and transitional fracture behavior absorb much more energy than plane-strain behavior due to the lack of thickness constraint on crack tip plasticity, and the assumptions of linear elastic fracture mechanics are violated. The in-plane geometric constraint on crack tip plasticity is required to ensure that gross plasticity is not the controlling mechanisms of fracture. Extensive study has indicated that the condition for CCP specimen instability for ductile materials is given by a net section stress criteria and not by a fracture (crack) controlled instability criteria. While the fracture toughness values for all plane strain type tests are reported, those values calculated for stress conditions where the net section stress (σ_{net} = Load/B(W-2a_c)) exceeds 80 percent of the tensile yield strength are marked with an asterisk. Values so marked are not utilized in any mean or standard deviation calculations summarizing plane-stress fracture critical properties.

2.3 THE APPARENT FRACTURE TOUGHNESS

The apparent fracture toughness (K_{App}) is a plane stress and transitional fracture toughness property that is sometimes utilized as a lower bound on the critical fracture toughness. Its initial purpose was to preclude measurements of the tearing process observed during fracture tests of CCP specimens. As noted in Figures 2.16 and 2.17, the initial crack length ($2a_o$) extends during the loading to the critical crack length ($2a_c$). The two simplest measurements to make in such a fracture test are those of the initial crack length ($2a_o$) and critical (maximum) stress at failure (σ_c). Thus, for simplicity, a K_{App} fracture toughness calculation was made using

$$K_{App} = \sigma_c \sqrt{\pi a_o} \cdot \left(\sec \frac{\pi a_o}{W} \right)^{\frac{1}{2}} \tag{2.7}$$

Equation 2.7 represents the stress-intensity factor corresponding to the stress and crack length condition at point "A" in Figure 2.16. It can be noted by comparing Equations 2.6 and 2.7 that K_{App} will always be less than or equal to K_c since $a_o \leq a_c$. Also, K_{App} will always be greater than or equal to K_{ONSET} since $\sigma_o \leq \sigma_c$. A comparison of the apparent fracture toughness with the onset and critical fracture toughness is shown in Figure 2.18 for a wide CCP specimen. When the net section stress (σ_{net} = Load/B(W-$2a_o$)) exceeds 80 percent of the tensile yield strength, the K_{App} values are marked with an asterisk. Values so marked are not utilized in any mean or standard deviation calculations summarizing plane-stress apparent fracture toughness properties.

2.4 R-CURVE (K_R VERSUS Δa_{eff})

The resistance curve (or R-curve) provides a complete description of the tearing fracture behavior illustrated in Figure 2.16. R-curves characterize the resistance to fracture of materials during incremental slow-stable crack extension and result from growth of the plastic zone as the crack extends. ASTM formalized the collection and

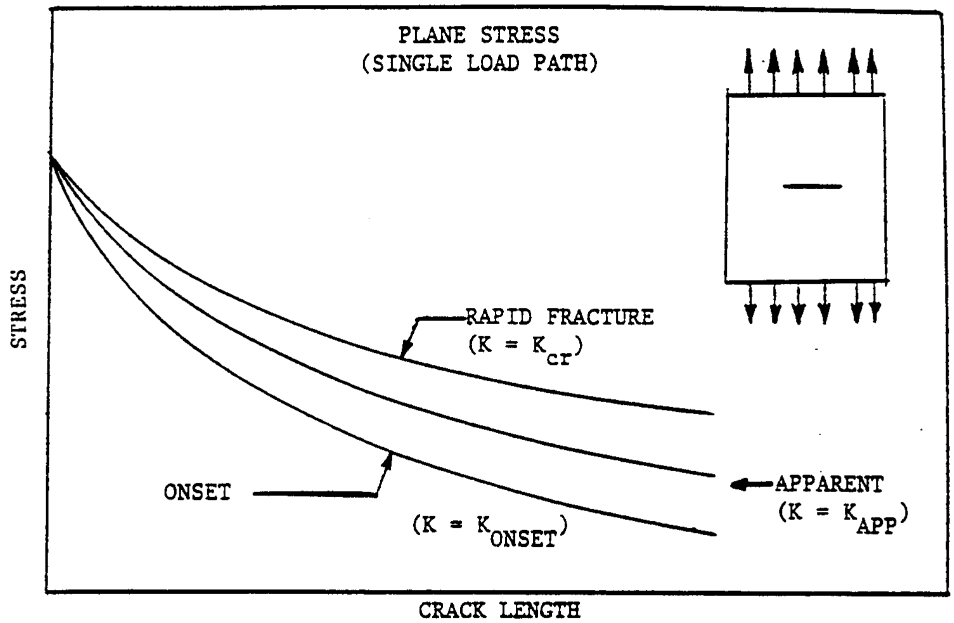


Figure 2.18 Description of the Three Fracture Toughness Criteria that are Utilized to Estimate Residual Strength Under Tearing Fracture Conditions.

reporting of such curves through ASTM Standard E561, covering the standard practice for R-Curve Determination. As stated by ASTM E561, R-curves provide "a record of the toughness development as a crack is driven stably under increasing applied K. They are dependent upon thickness, temperature, and strain rate."

The value of K_R (toughness) is calculated using standard stress-intensity factor equations evaluated with the instantaneous values of applied stress (σ) and crack length (a), as the crack extends. To account for the effects of plasticity, the measured crack length is enhanced with a plastic zone correction, and an effective crack length (a_{eff}) is actually used in the calculation of K_R. For example, when a CCP specimen is used to collect tearing resistance data, the K_R is calculated based on the standard stress-intensity factor equation (SIF.1) given in Table 2.3.

$$K_R = \sigma \sqrt{\pi a_{eff}} \cdot \left(Sec \frac{\pi a_{eff}}{W} \right)^{\frac{1}{2}} \tag{2.8}$$

where σ and a_{eff} are the current stress and effective crack length measurements in the test. The effective crack length for optical measurements is calculated from

$$a_{eff} = a + r_y \tag{2.9}$$

where a is the optically measured crack length and r_y , calculated as

$$r_y = \frac{1}{2\pi} \left(\frac{K}{\sigma_{ys}} \right)^2 \tag{2.10}$$

is the plastic zone size for the current applied stress and crack length. If the crack length is automatically monitored by compliance techniques, then the effective crack length is automatically obtained using the two compliance equations presented in ASTM E561.

The K_R value calculated from Equation 2.8 can be described as a function of the increment of physical crack extension ($\Delta a = a - a_o$, a_o = initial crack length) or as suggested by ASTM 561 as a function of the increment of effective crack length ($\Delta a_{eff} = (a + r_y) - a_o$). The functions K_R versus Δa and K_R versus Δa_{eff} are referred to as R-curves (or resistance curves). Data presented in this Handbook correspond to the use of the ASTM E561 definition of R-curves, i.e., K_R is presented as a function of Δa_{eff}.

All new and existing R-curve data were validated by ensuring that the remaining specimen ligament in the plane of the crack was predominantely elastic. For CCP specimens, ASTM Standard E561 requires the net section stress based on the physical crack size be less than the yield strength of the material, or

$$\sigma_{net} < \sigma_{ys} \quad ; \quad \sigma_{net} = \frac{P_{cr}}{B(W-2a)} \tag{2.11}$$

For compact tension (CT) specimens, the validity criteria is given by

$$W-a \geq \frac{4}{\pi}\left(\frac{K_{max}}{\sigma_{ys}}\right)^2 \tag{2.12}$$

where K_{max} is calculated using the physical crack size in conjunction with equation SIF.2 in Table 2.3.

The majority of R-curve data available for the Handbook were obtained using a compliance based technique for measuring the crack length. The compliance based technique provides a direct measure of the effective crack length, and therefore does not require use of Equations 2.9 and 2.10 to estimate the plastic zone size correction. Therefore, when a compliance based measurement technique is used, only the effective crack length, effective K_R, and Δa_{eff} are reported. As a result, the validity criteria given by Equations 2.11 and 2.12 were checked using the effective crack length for those data obtained by a compliance based technique. In some instances,

this resulted in the last few data points of a particular data set to not meet the criteria given by Equation 2.12. However, previous experience has shown that the effect of using Δa_{eff} in Equation 2.12 may be such that the test in question may appear to be invalid, when in reality it is not. Based on this and the fact that the tests in question were completed in accordance with ASTM Standard E561, these R-curves, identified by an asterisk, are included in the Handbook.

One of the fundamental hypotheses behind the application of R-curves to the prediction of tearing type fractures in thin structures and in structures fabricated from ductile materials is that the R-curve (material tearing resistance) is independent of crack length for a given geometry and is independent of geometry and external loading. As long as the structure matches the monotonically increasing stress-intensity factor conditions given by the R-curve, the structure will exhibit the same tearing resistance experienced in the laboratory test specimen. The Damage Tolerant Guidelines Handbook (AFWAL-TR-82-3073) describes how the R-curve can be applied to the calculation of critical stress levels in structures.

2.5 FATIGUE CRACK GROWTH RATE

2.5.1 Fatigue Crack Growth Behavior

Under some loading conditions or environmental conditions, cracks can grow at load levels well below that required to cause fracture. As the crack continues to grow, conditions become more favorable for fracture, and eventually under the applied loading fracture does occur. This process whereby cracks are observed to grow at subcritical load levels is referred to as subcritical crack growth. Illustrated in Figure 2.19 is a fatigue crack growth curve, which shows the type of behavior typically observed during a specific subcritical crack growth process; in this case, damage is done to the material by cyclic (or fatigue) loading. This section addresses properties used to measure fatigue crack growth behavior and Sections 2.6 and 2.7 address properties used to characterize sustained load cracking in an environment.

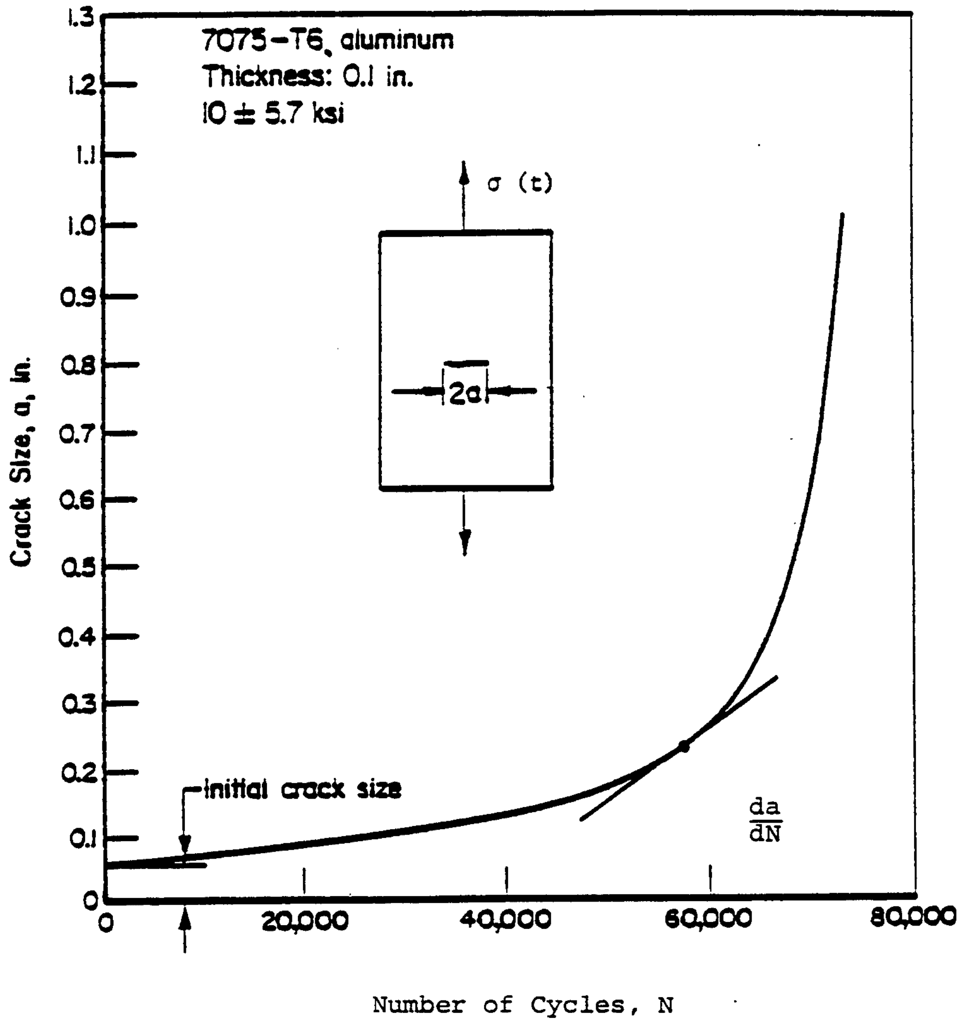


Figure 2.19 Typical Crack Growth-Life Curve.

The objective of fatigue crack growth testing is to determine the rates at which subcritical flaws propagate under cyclic loadings prior to reaching a size critical for fracture. These rates are determined from measurements of the crack extension occurring over an increment of cyclic loading. Typically, these measurements are made by monitoring crack extension optically on the specimen surface during the test. From the basic crack length and cycle count data, the fatigue-crack growth rate is determined as the quotient of the incremental crack growth divided by the incremental cycle count, i.e., $\Delta a/\Delta N$ or da/dN, the slope of the crack growth (life) curve.

The crack growth rate measures the resistance of the material to the applied loading conditions. The similitude parameter that allows data to be transferred from one cracked geometry to another is the range in stress-intensity factor (ΔK). The ΔK parameter is the difference between the maximum and minimum stress-intensity factors (K_{max} and K_{min}, respectively) for a cycle of loading. The property of fatigue crack growth rate is described throughout this Handbook as a function of ΔK.

2.5.2 Data Acceptance Criteria

In general, similar specimen configurations are used for fatigue-crack-growth testing as are used for other types of damage tolerant tests. The applied loads are reduced in magnitude and are cyclic in nature for studies of crack extension under fatigue loading conditions, and the experimental methods are extensions of the fracture testing procedures previously described. Instead of applying either a rising or sustained load to fracture the specimen, a constant amplitude cyclic load is applied to initiate and grow the crack over a significant portion of the specimen width. ASTM has published a standard testing method, i.e., ASTM E647, which covers the collection and reporting of fatigue crack growth rate data. Most of fatigue crack growth rate data reported in the Handbook were collected and reduced utilizing the guidelines and methods described by ASTM E647. For CCP and CT specimen

geometries, the ASTM Standard describes 11 explicit criteria for validating the data; these criteria are summarized in Table 2.4. A field is included in the handbook database which notes the da/dN data that failed to meet these ASTM criteria.

2.5.3 Data Reduction Procedures

Data reduction of crack growth rate from the crack length versus cycle count data was by one of two methods. The secant method was chosen when there were seven or less crack length versus cycle count measurements. A five point polynomial movable strip method was used for data with more than seven crack length versus cycle count measurements. This procedure was similar to the seven point method recommended in the ASTM standard; the five point method was chosen to provide additional data points at the extremes of growth rate range.

It is important to note that the calculation of stress-intensity factor range (ΔK) is the difference between the maximum and minimum stress-intensity factors (K_{max} and K_{min}, respectively) as defined in ASTM Standard E647. These calculations are best expressed using equations specific to a given geometry; for illustration purposes, assume that the test specimen geometry is CCP. Then, the maximum and minimum stress-intensity factors are given by

$$K_{max} = \sigma_{max} \sqrt{\pi a} \left(\sec \frac{\pi a}{W} \right)^{\frac{1}{2}} \tag{2.13}$$

and

$$K_{min} = \sigma_{min} \sqrt{\pi a} \left(\sec \frac{\pi a}{W} \right)^{\frac{1}{2}} \tag{2.14}$$

where σ_{max} and σ_{min} are the maximum and minimum stresses in the applied loading cycle. The range of stress-intensity factor is defined as

$$\Delta K = K_{max} - K_{min} \tag{2.15}$$

By ASTM convention, if K_{min} is compressive (negative), then $K_{min} \equiv 0$, and $\Delta K = K_{max}$.

TABLE 2.4

CRITERIA CHECKS FOR FATIGUE CRACK GROWTH RATE DATA

Criteria No.	ASTM E647 Paragraph	Specimen Type	Criterion
1	7.1.3.1 7.1.3.2	CT CCP	$\frac{W}{20} \leq B \leq \frac{W}{4}$ $B \leq \frac{W}{8}$
2	Figure 1	CT CCP	$W \geq 1.00$ inch. None
3	8.8.2	CT and CCP	If $B/W \geq 0.15$ need front and back crack lengths.
4	7.1.1 7.1.2	CT CCP	$a_N \geq 0.2W$ $2a_N \geq 0.2W$ if compliance crack length measurement technique used
5	8.3.1	CT and CCP	$a_1 \geq 0.1B$, h, or 0.04 inch, whichever is greater
6	8.8.3	CT and CCP	(Front Crack Length-Back Crack Length) < 0.025 W or 0.25 B, whichever is less.
7	8.8.1.1 8.8.1.2	CT CCP	if $0.25 \leq a/W \leq 0.40$ then $\Delta a \leq 0.04$ W $0.40 \leq a/W \leq 0.60$ then $\Delta a \leq 0.02$ W $a/W \geq 0.60$ then $\Delta a \leq 0.01$ W if $2a/W \leq 0.60$ then $\Delta a \leq 0.03$ W $2a/W > 0.60$ then $\Delta a \leq 0.02$ W
8	8.8.1.3	CT and CCP	$\Delta a \geq 0.01$ inch, except in threshold region
9	7.2.1 7.2.2	CT CCP	$W - a \geq \frac{4}{\pi} (K_{max}/TYS)^2$ $W - a \geq 1.25\, P_{max}/(B*TYS)$
10	8.5.1	CT and CCP	<u>In Test</u>, Load Variation $0 \leq \left\lvert \frac{P_{max_{a+1}} - P_{max_a}}{P_{max_a}} \right\rvert \leq 0.10$
11	8.3.2	CT and CCP	<u>In Precracking</u> (1) $\frac{P_{max_{a+1}} - P_{max_a}}{P_{max_a}} \leq 0.20$, and (2) $\Delta a \geq (3/\pi)(K^*_{max}/TYS)^2$

CT = Compact Tension
CCP = Center Cracked Panel
B = Specimen Thickness
W = Specimen Width
a = Crack Length
a_N = Notch Size
a_1 = Fatigue Precrack Length

h = Height of Specimen
Δa = Change in Crack Length
P_{max} = Maximum Load
K_{max} = Maximum Stress Intensity
TYS = Tensile Yield Strength
K^*_{max} = Maximum Stress Intensity at Smaller Crack Length Being Considered

2.5.4 Data Reporting Procedures

The presentation of fatigue-crack-propagation rate data is far more complex than the presentation of fracture toughness data (either K_{Ic} or K_c) due to the large quantities of data which must be treated. Where a fracture test generally yields a single characteristic toughness value, a fatigue-crack-growth test specimen generally yields from 10 to 100 rate data points, da/dN, which must be evaluated in terms of the stress-intensity factor range, ΔK.

The Damage Tolerant Design Data Handbook presents fatigue crack growth rate (da/dN) data in both graphical and tabular formats. Subsection 1.6.1 fully describes the presentation format of these data. A graphical format is used to present da/dN versus ΔK data and the mean trend of these data are given in tabular form. The least squares cubic spline approximation method has been selected from those available to provide a practical method for generating tables with fixed ΔK values. A least squares cubic spline approximation is an analytic method of fitting a "French" curve to a data set. The curve is constructed by fitting different cubic polynomials on non-overlapping, connecting subintervals over the range of the independent variable. In the Handbook, the independent variable will be ΔK. The boundary points of the intervals are referred to as knots and the cubic polynomials meet at the knots. The polynomials are also constrained so that the first and second derivatives are continuous at the knots. The result of this process is a smooth curve which passes through the center of the data.

Figure 2.20 is an example of a spline curve fit to a da/dN data set reported by Hudak et al. for 2219-T851 Aluminum alloy. The stress ratio used to establish the data shown was 0.3. The knots are marked in the figure by the large dots.

In general, da/dN data are well enough behaved so that a maximum of five knots was sufficient in generating the handbook tables. The actual number

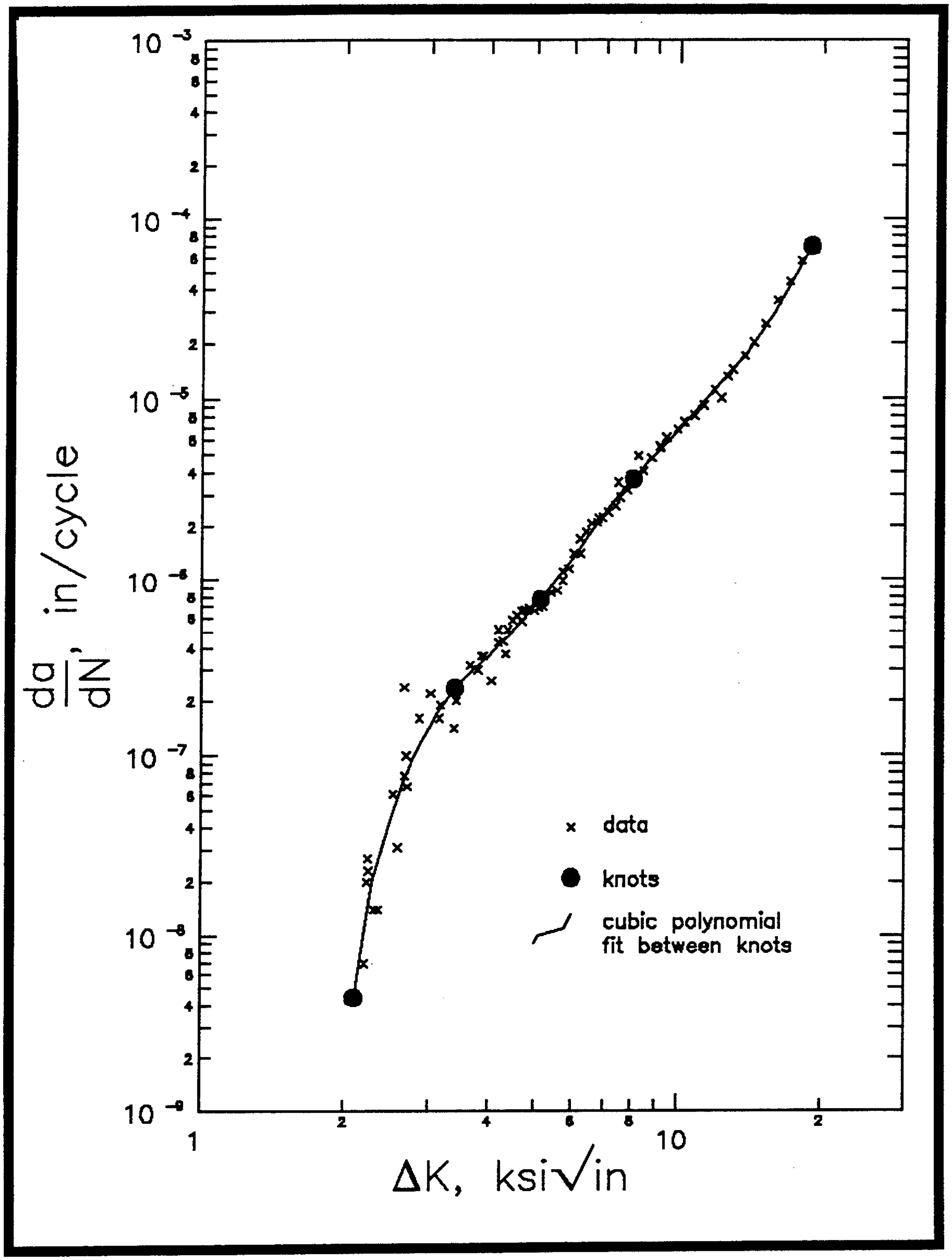


Figure 2.20 A Cubic Spline Curve Fit to FCGR Data for 2219-T851 Aluminum at a Stress Ratio of 0.3.

of knots used in fitting a curve to a set of data is a function of the root mean square percent error of the fit to the data and the pattern of the fitted line in da/dN-ΔK space.

The mean trend table for a set of da/dN data is generated by selecting points from the spline curve that has been fit to the data. The ΔK values will be chosen such that they are approximately equally spaced in a logarithmic scale and cover the complete range of ΔK values expected. The da/dN values are obtained through the interpolation of the spline curve at the preselected ΔK values. The complete set of ΔK values have been given previously in Table 1.11. Because the da/dN data do not always span the complete ΔK range, the table also reports the minimum and maximum da/dN values corresponding to the recorded minimum and maximum ΔK values. The extreme pairs of (ΔK, da/dN) points correspond to the extremes of the spline curve.

The root mean square percent error (RMSPE) is utilized to describe the statistical accuracy for the spline curve fit at each value of the varying parameter. The RMSPE is given by:

$$RMSPE = 100 \; x \; \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i - \hat{y}_i}{\hat{y}_i}\right)^2} \tag{2.16}$$

where

y_i = observed $da/dN|_i$ at ΔK_i

$\hat{y}_i$ = da/dN interpolated from table at ΔK_i.

The RMSPE is a measure of how close the data lie to the mean trend table and has a similar interpretation to the coefficient of variation, i.e., the smaller the better. The coefficient of variation is used when all the data have the same mean and is calculated by dividing the standard deviation by the mean and multiplying by 100. For da/dN data, the mean da/dN is a function of ΔK so this is taken into account

when calculating the RMSPE. The RMSPE is an average percent error of the observed da/dN values from the curve established by the mean trend table.

When evaluating the mean trend da/dN description, engineers have come to rely on an evaluation of the ability of the mean trend curve to repredict the initial a versus N data and, in particular, to rely on life prediction ratio (N_p/N_A) which relates the predicted number of cycles (N_p) required to propagate a crack through a specified increment to the actual number of cycles (N_A) observed to propagate a crack through the same increment. Life prediction ratios between 0.8 and 1.25 are considered good and a life prediction ratio of 1.0 is ideal.

As a second measure of how well the mean trend curve fits the data, a summary of the life prediction ratios for the specimens used to generate the mean trend curve is included at the bottom of Figure 1.12. This summary places the plot symbol assigned to a specimen test along the LPRS scale at its calculated location. The actual LPRS value is greater than 2 for tests whose plot symbols are placed beyond 2 in the LPRS scale.

The life prediction ratios summarized in Figure 1.12 are self predictions and as such will tend to be good. However, the summary is only valid for the data used to generate it and therefore should not be generalized to other situations. The life prediction ratio summary is not intended to predict how well the mean trend curve will predict crack growth for an arbitrary specimen; however, it does illustrate how well the mean trend in FCGR correlates with the lives of the cracks that were used in generating the mean trend.

2.6 SUSTAINED-LOAD CRACK GROWTH RATES

2.6.1 Sustained-Load Crack Growth Rate Behavior

Sustained-load crack growth rate behavior is another type of subcritical crack growth behavior exhibited by materials which are sensitive to environmental

attack. This type of subcritical crack growth behavior normally exhibits itself as a time-dependent crack growth rate process, whereby cracks are noted to extend under steady-state (sustained) static loading conditions in the presence of environments. Crack growth mechanisms controlling the sustained-load crack growth rate process include: stress-corrosion cracking, hydrogen embrittlement, liquid metal embrittlement, grain boundary separation, and creep. In practice, the time-dependent cracking process has been found to be driven by internal (residual) tensile stresses in the fabricated structure, even in the absence of externally applied loads; typically, however, the stressing condition which drives the crack is provided by external loads.

The objective of sustained-load crack growth testing is to determine the rates at which cracks propagate in precracked specimens subjected to statically applied loads and prescribed environmental conditions. As with fatigue crack growth rate tests, most of the crack length measurements are made optically on the specimen surface during the test. Nonoptical methods used to establish cracking include compliance and stress wave analysis techniques. From the basic crack length and time data, the sustained-load crack growth rate is determined as the quotient of the incremental crack growth divided by the incremental time, i.e., $\Delta a/\Delta t$ or da/dt, the slope of the crack growth (time to failure) curve.

The crack growth rate measures the resistance of the material to the applied loading for the specified environment. In this case, the similitude parameter that allows data to be transferred from one cracked geometry to another is the static stress-intensity factor (K_{max}). The K_{max} parameter is the stress-intensity factor evaluated for the applied loading and current crack length. The property of sustained-load crack growth rate (da/dt) is described throughout this Handbook as a function of K_{max}.

2.6.2 Data Acceptance Criteria

For the most part, the testing methodology for da/dt properties follows that utilized to obtain da/dN properties. There are, however, no current ASTM standards that specifically cover the collection of da/dt data. Sustained-load data have been obtained with a variety of specimens including double cantilever beams (DCB), tapered double cantilever beams (TDCB), compact tension (CT) specimens, cantilever beams (CANT), single-edge-notch tensile (SENT) specimens, part-through-surface crack (PTSC) specimens, and center-cracked panel (CCP) specimens.

One validity criterion that is sometimes applied to da/dt data is that the thickness dimension and crack length must be greater than 2.5 $(K_{Ic}/\sigma_{ys})^2$. No da/dt data were excluded from the 1993 revision, however, based on this criteria due to the scarcity of da/dt data. The reader will find K_{Ic}, σ_{ys} and thickness reported with da/dt data whenever these were available.

Readers should note that sustained load crack growth rate data in aluminum alloys in planes other than those parallel to the surface of rolled plates are questionable because of the localized corrosion that occurs on the planes even though the initial notch and crack orientation are normal to these planes.

2.6.3 Data Reduction Procedures

Data reduction of sustained-load crack growth rates was accomplished using the secant method applied to crack length (a) measurements recorded as a function of time (t). These calculations and those of static stress-intensity factor were provided to the data processing organization for reformatting.

2.6.4 Data Reporting Procedures

The data reporting procedures for sustained-load cracking data are similar to those discussed in Subsection 2.5.4 for fatigue crack growth rates. The

major difference between the two subcritical cracking rate reporting procedures is that da/dt vs K_{max} describes the sustained-load behavior whereas da/dN vs ΔK describes the fatigue behavior. The reader might also note that no a vs t were available to compare with the integrated crack growth mean trend data and therefore no life prediction ratios were presented.

2.7 THRESHOLD STRESS INTENSITY (K_{Iscc})

2.7.1 The Threshold

In many environments, materials exhibit a condition whereby cracks are not observed to grow if the static stress intensity factor is below a critical level, designated K_{Iscc}. This property is specific for a given material in a given environment within a specified time period. In high-strength materials, K_{Iscc} may be only a small fraction of the plane-strain fracture-toughness value (K_{Ic}) of the material. In lower strength tougher materials where plane-strain conditions still prevail, K_{Iscc} may approach or equal K_{Ic}, if the environment has little or no effect on the stress intensity required to propagate a crack.

K_{Iscc} data have been obtained with a variety of specimens including: Cantilever beam (CANT), 3-point loaded bend beam (NB), 4-point loaded bend beam (4-NB), Single-edge notch tensile (SENT), Center-cracked tensile (CNT), Part-through surface-crack (PTSC), Compact tension (CT), Bolt loaded WOL (BWOL), Double cantilever beam (DCB), and Tapered or contoured double cantilever beam (TDCB). All specimens are notched and precracked by fatigue, and many specimens are side grooved (SG) to ensure that the crack propagates in one plane perpendicular to the applied tensile loading and also to minimize the contribution of shear lips at the edges of the crack.

The types of specimens for determining K_{Iscc} fall into two broad categories: those that are loaded by weights or tensile machines (see Figure 2.21) and

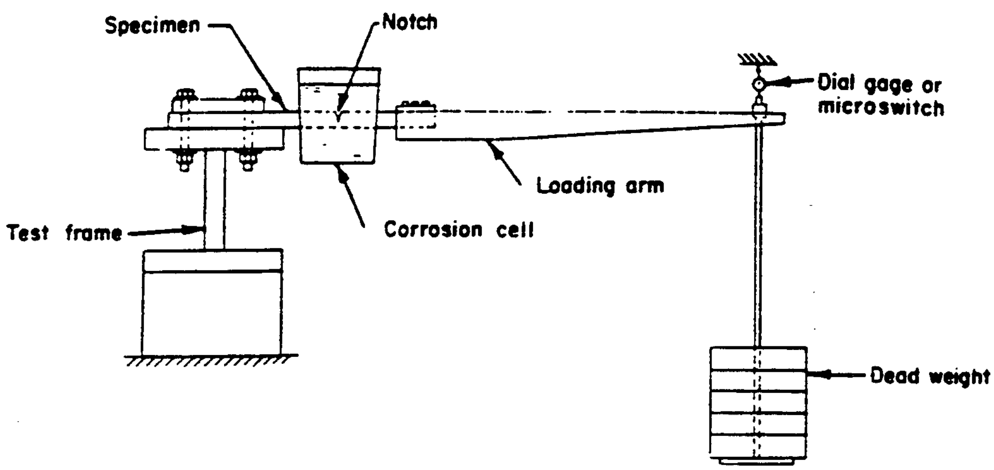


Figure 2.21 Schematic Drawing of Fatigue Cracked Cantilever Beam Test Specimen and Fixtures.

those that are self-loaded as by bolts. The former require bulky setups to accommodate lever arms, weights, and tensile machines while the latter are compact and portable. Thus the environment is applied to the externally loaded specimens usually in the form of a small container sealed onto the specimen, while the self-loaded specimen may be completely immersed in the environment.

Under dead-weight loading conditions, the usual practice is to run a number of specimens at various stress intensities less than K_{Ic} for a finite length of time (more than 24 hours and usually about 500 hours) to establish K_{Iscc}. Another method is to step load a single specimen until the crack starts to propagate. This method requires holding after each load increment for a sufficient time to establish that crack propagation does not occur.

Under bolt self-loading conditions, sufficient load is first applied to the bolt to cause the crack to extend beyond its precracked position. The specimen is then exposed to the environment. As the crack propagates in the environment, the stress-intensity factor decreases at the tip of the advancing crack until the crack arrests at K_{Iscc}. Specimen length must be sufficient to ensure that the crack arrests before completely penetrating the specimen, thus assuring that a value is obtained for K_{Iscc}.

2.7.2 Conditions for Validity of Data

There are no ASTM standards that specifically cover the collection of K_{Iscc} data. The criterion typically used to validate K_{Iscc} data is that the thickness dimension (B) and initial crack size after precracking (a_o) are greater than the ASTM E399 requirement for plane-strain fracture toughness, i.e., that B and $a_o \geq 2.5 (K_{Ic}/\sigma_{ys})^2$. However, because the initial crack size is not currently stored in the handbook database, only the thickness requirement was checked. Data which did not meet this criterion are identified in the K_{Iscc} tables with an asterisk. Many tests reveal a drastic reduction in the stress intensity required to propagate a crack even

though the 2.5 $(K_{Ic}/\sigma_{ys})^2$ criterion is not met. Although these data are not recommended for material selection and design purposes, they do indicate a qualitative effect.

CHAPTER 3
ALLOY STEEL SECTIONS

TABLE 3.0.1

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
10NI STEEL	Unspecified	Plate				13		
12-9-2 (MAR)	STA 900	Round Bar	1			2		
12NI-5CR-3MO	Unspecified	Unspecified						3
		Plate						4
	1500F 900F 20HR AC	Plate						2
	ELECTRIC FURNACE	Plate						1
	GTA WELDED	Weldment						1
	LOW-RESIDUAL	Plate						1
	TYS=150KSI	Plate						1
	TYS=160KSI	Plate						1
	TYS=170KSI	Plate						1
	TYS=175KSI	Plate						1
18NI(180)(MAR)	1500F 1HR AC 900F 3HR	Plate						2
	TYS=170KSI	Plate						1
	TYS=175KSI	Plate						1
	TYS=178KSI	Plate						1
	TYS=185KSI	Plate						1
	TYS=190KSI	Plate						1
	TYS=195KSI	Plate						1
	TYS=200KSI	Plate						1
18NI(200)(MAR)	Unspecified	Plate						1
	1500F 1HR AC 900F 3HR	Plate						2

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
18NI(200)(MAR) (Cont'd)	1650F 4.5 HR AC AGED 1000F 6HR	Plate	3					
	1650F 4.5 HR AC AGED 850F 24HR	Forging	1					
	1650F 4.5 HR AC AGED 900F 24HR	Plate	2					
	1650F 4.5 HR AC AGED 900F 6HR	Forging	3					
	1650F 4.5 HR AC AGED 950F 24HR	Plate	3					
	1650F 900F 3HR AC	Plate						1
	1675F 2HR AC 500F 0.25HR 850F 4HR COOL 250F/MIN	Plate						1
	1675F 2HR AC 500F 15MIN 850F 4HR COOL 250F/MIN	Plate						1
	TYS=215KSI	Plate						1
	WELD CENTER LINE	Plate						1
18NI(250)	Unspecified	Unspecified					2	
		Plate					1	
18NI(250)(MAR)	Unspecified	Plate						6
	1500F 1HR AC AGED 900F 3HR AC	Billet	13					
	1500F AC 850F 6HR	Plate	5					
	1500F AC 900F 24HR	Plate	6					
	1500F AC 900F 6HR	Plate	6					
	1500F AC 950F 6HR	Plate	6					
	1650F 1.25HR WQ 1525F 1.25HR WQ 900F 3HR AC	Plate						3
	900F 2HR AC	Sheet						2
	AGE 900F 3HR	Plate						1

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
18NI(250)(MAR) (Cont'd)	AGED 900F 3HR AC	Plate						2
	TYS=250KSI	Plate						1
	TYS=260KSI	Plate						1
	UTS=243KSI	Billet				3		
18NI(280)(MAR)	1500F 1HR AC 900F 3HR	Plate						1
18NI(300)	Unspecified	Unspecified					1	
	AGED 6HR 900F	Unspecified					1	
18NI(300)(MAR)	Unspecified	Sheet		29				
		Forging				7		
	1500F 0.5HR AC900F 3HR	Plate						2
	1500F 2HR 800F 10HR	Bar						4
	1500F 2HR 900F 100HR	Bar						5
	1500F 2HR 900F 3.5HR	Bar						5
	1700F 1500F AGED 900F 6HR	Forging						1
	1700F 1HR AC 1500F 1HR AC 900F 6HR	Forging	5					
	2300F 1HR 1700F 4HR 800F 10HR	Bar						2
	2300F 1HR 1700F 4HR 900F 100HR	Bar						3
	2300F 1HR 1700F 4HR 900F 3.5HR	Bar						2
	900 F AGED	Plate	1					
	900F 3HR 950F 3HR	Forging						1
	AGE 900F 6HR	Forging						3
	AGE 950F 12HR	Forging						1

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
18NI(300)(MAR) (Cont'd)	AGED	Unspecified				2		
	ANNEALED	Unspecified				2		
	CRACK PRESTRESSED TO 25 PCT KIC	Forging						1
	CRACK PRESTRESSED TO 50 PCT KIC	Forging						1
	CRACK PRESTRESSED TO 80 PCT KIC	Forging						1
18NI(350)	AGED 8HR 800F	Unspecified					1	
18NI(350)(MAR)	1500F 1HR 800F 8HR	Forging						1
	1500F 1HR 900F 8HR	Forging						1
	1500F 1HR 950F 3HR	Forging						1
	AGE 800F 8HR	Forged Bar						1
	AGE 900F 3HR	Forged Bar						1
	AGE 900F 8HR	Forged Bar						1
300M	Unspecified	Unspecified					1	
		Plate						2
		Forging	8			14		4
	1500F 0.5HR OQ 550F 2+2 HR (COARSE GRAINED STRUCTURE)	Plate						1
	1500F 0.5HR OQ 550F 2+2 HR (FINE GRAINED STRUCTURE)	Plate						1
	1500F 0.5HR OQ400F 2+2 HR (COARSE GRAINED STRUCTURE)	Plate						1
	1500F 0.5HR OQ400F 2+2 HR (FINE GRAINED STRUCTURE)	Plate						1

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
300M (Cont'd)	1550F 0.5HR OQ 400F 2+2 HR (COARSE GRAINED STRUCTURE)	Plate						1
	1550F 0.5HR OQ 400F 2+2 HR (FINE GRAINED STRUCTURE)	Plate						1
	1550F 0.5HR OQ 550F 2+2 HR (COARSE GRAINED STRUCTURE)	Plate						1
	1550F 0.5HR OQ 550F 2+2 HR (FINE GRAINED STRUCTURE)	Plate						1
	1600F 0.5HR OQ 400F 2+2 HR (COARSE GRAINED STRUCTURE)	Plate						1
	1600F 0.5HR OQ 550F 2+2 HR (COARSE GRAINED STRUCTURE)	Plate						1
	1600F 0.5HR OQ 550F 2+2 HR (FINE GRAINED STRUCTURE)	Plate						1
	1600F 0.5HR SQ 1000F 0.5-1.0HR OQ 80-180F 25MIN 575F 2+2HR	Forging	12					
	1600F 1.25 HR OQ 600F 2+2HR	Forging	10					
	1600F 1HR OQ 1HR WQ 475F 1HR	Bar	1					
	1600F 1HR OQ 475F 1HR	Bar	1					
	1600F 1HR OQ 575F 1HR	Bar	1					
	1600F 1HR OQ 615F 1HR	Bar	1					
	1600F 1HR OQ 745F 1HR	Bar	1					
	1600F OQ 550F 2+2HR	Plate	1					
	1600F OQ 575F 2+2HR	Sheet					1	
	1650F 1525F OQ600F 2+2HR	Forging						1
	1650F 1600F 1HR OQ 600F 1+1 HR	Forging						1

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
300M (Cont'd)	1675F AC 1575F OQ 1100F 2HR (RC 39)	Plate	4					
	1675F AC 1575F OQ 500F 2HR (RC 51.5)	Plate	4					
	1675F AC 1575F OQ 800F 2HR (RC 47.5)	Plate	4					
	1700F 1.5HR AC 1600F 1.5HR OQ 600F 2+2HR	Forging						12
	1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS	Forging				10		
	1700F 1HR AC 1600F 1HR OQ 600F 2HR AC (AMS 6419)	Plate	3					
	1710F+1610F 610F	Bar						7
	2190F 1HR FC TO 1600F HOLD 0.5HR OQ 475F 1HR	Bar	2					
	2190F 1HR FC TO 1600F HOLD 0.5HR OQ 615F 1HR	Bar	1					
	2190F 1HR FC TO 1600F HOLD 0.5HR OQ 745F 1HR	Bar	1					
	2190F 1HR OQ 400F 1HR	Bar	1					
	2190F 1HR OQ 475F 1HR	Bar	1					
	2190F 1HR OQ 475F 1HR W1 475F 1HR	Bar	1					
	2190F 1HR OQ 615F 1HR	Bar	1					
	2190F 1HR OQ 745F 1HR	Bar	1					
	AMS 6434	Sheet		3				
		Plate		15				
	HEAT TREATED TO 54 RC HARDNESS	Plate	2					
	UTS=280-300KSI	Billet				20		
		Bar				3		

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
300M (AM)	1650F 1HR AC 1550F 1HR OQ -320F 0.5HR 600F 2+2HR AC	Forging	3					
300M (VAR)	1650F 1HR AC 1550F 1HR OQ -320F 0.5HR 600F 2+2HR AC	Forging	4					
300M (VM)	1500F OQ 400F 2+2HR	Plate	2					
	1500F OQ 550F 2+2HR	Plate	2					
	1550F OQ 400F 2+2HR	Plate	1					
	1550F OQ 550F 2+2HR	Plate	2					
	1600F OQ 400F 2+2HR	Plate	1					
	1600F OQ 550F 2+2HR	Plate	1					
	1700F AC 1600F 1HR OQ 550F 2+2HR	Billet	3					
	1700F AC 1600F 1HR SQ 400F AC 550F 2+2HR	Billet	3					
	1700F AC 1600F 1HR SQ 975F OQ 575F 2+2HR	Billet	3					
4140	1550F 1HR OQ 1000F 1HR AC 1125F 1HR AC	Plate						1
	1550F 1HR OQ 1250F 1HR AC	Plate						1
	1600F 1 HR OQ 400F 1HR	Forged Bar	1					
	1600F 1 HR OQ 535F 1HR	Forged Bar	1					
	1600F 1 HR OQ 745F 1HR	Forged Bar	1					
	1600F 1HR 1550F 1HR OQ AT 150-175F 900F 1HR	Plate	10					
	1700F 1600F OQ 600F 1+1 HR	Plate						1
	1700F 1600F OQ 750F 1+1 HR	Plate						1
	2010F 1 HR OQ 400F 1HR	Forged Bar	1					
	2010F 1 HR OQ 475F 1HR	Forged Bar	2					

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
4140 (Cont'd)	2190F 1 HR OQ 400F 1HR	Forged Bar	2					
	2190F 1 HR OQ 475F 1HR	Forged Bar	2					
	2190F 1 HR OQ 615F 1HR	Forged Bar	1					
	2190F 1 HR OQ 660F 1HR	Forged Bar	1					
4330V	QUENCHED + TEMPERED AT 500F	Plate						1
4330V (MOD)	Unspecified	Billet	3			1		
	1600F 1HR OQ 400F 1HR	Forged Bar	1					
	1600F 1HR OQ 535F 1HR	Forged Bar	2					
	1650F 1HR AC 1575F 1HR OQ 800F 2+2HR	Billet	9					
	HEAT TREATED TO 46 RC HARDNESS	Plate	2					
4340	Unspecified	Unspecified					1	
		Sheet						2
		Plate					1	1
		Forging						1
	1350F OQ 750F 1.25HR	Plate						1
	1550F OQ 750F 1HR CRACK PRESTRESSED TO 20PCT KIC	Plate						1
	1550F OQ 750F CRACK PRESTRESSED TO 20PCT KIC	Plate						1
	1550F OQ 750F CRACK PRESTRESSED TO 40PCT KIC	Plate						1
	1550F OQ 750F CRACK PRESTRESSED TO 60PCT KIC	Plate						1

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
4340 (Cont'd)	1550F OQ 750F CRACK PRESTRESSED TO 80PCT KIC	Plate						1
	1550F OQ TEMPERED 500F	Plate	4					
	1550F OQ TEMPERED 800F	Plate	2					
	1575F OQ 675F 4HR	Plate						1
	1575F OQ 800F 4HR	Plate						1
	1600F 1HR 1525F 2.5HR OQ AT 150-175F 900F 1HR	Plate	6					
	1600F 1HR OQ 400F 1HR	Forged Bar	1					
	1600F 1HR OQ 535F 1HR	Forged Bar	2					
	1600F 1HR OQ 600F 1+1HR	Forging						1
	1600F 1HR OQ 660F 1HR	Forged Bar	1					
	1600F 1HR OQ 745F 1HR	Forged Bar	1					
	1625F Q 1525F OQ 400F 2+2HR 1625F Q 1525F OQ	Forging						2
	1650F 1HR AC 1480F 2HR OQ LN 0.25HR 400F 1+1HR OQ	Bar						1
	1650F 1HR AC 1680F 2HR OQ LN 0.25HR 400F 1+1HR OQ	Bar						1
	1650F 1HR AC 1525F 1HR OQ 800F 2HR	Billet	6					
	1700F 0.25HR AC 1550F OQ 600F 1+1HR	Sheet						2
	1800F Q 600F 1+1HR	Forging						12
	2190F 1HR FC TO 1600F HOLD 0.5HR 400F 1HR	Forged Bar	2					
	2190F 1HR FC TO 1600F HOLD 0.5HR 535F 1HR	Forged Bar	2					
	2190F 1HR FC TO 1600F HOLD 0.5HR 660F 1HR	Forged Bar	2					

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
4340 (Cont'd)	2190F 1HR OQ 475F 1HR	Forged Bar	1					
	2190F 1HR OQ 535F 1HR	Forged Bar	1					
	450F TEMPER	Unspecified				2		
	750F TEMPER	Unspecified				9		
	HEAT TREATED TO 51 RC HARDNESS	Plate	2					
	MARTEMPERED	Plate				4		
	TEMPER 400F 1HR	Plate					8	
	TEMPERED 400F	Unspecified					4	
	TYS=125KSI	Plate						1
	TYS=150KSI	Plate						1
	TYS=175KSI	Plate						1
	TYS=200-240KSI	Extrusion					4	
	TYS=200KSI	Plate						1
	TYS=220KSI	Forging					2	
	TYS=225KSI	Plate						1
	UTS=150KSI	Unspecified				4		
		Forging				3		
	UTS=160-180KSI	Bar				9		
	UTS=160KSI	Round Bar				3		
	UTS=180 KSI	Round Bar	1					
	UTS=180-200KSI	Plate				2		
		Bar				2		

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
4340 (Cont'd)	UTS=180KSI	Forging				7		
		Round Bar				10		
4340 (AM)	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	3					
4340 (DH)	1550F OQ 900F 1HR	Billet	12					
	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	10					
4340 (EFM)	1550F .5HR 400F 4HR	Plate					1	
4340 (MOD)	1650F 1HR 1600F 1HR OQ 1+1 400F (0.09 SI)	Bar						1
	1650F 1HR 1600F 1HR OQ 1+1 600F (0.09 SI)	Bar						1
	1800F Q 460F 1+1HR (0.20C)	Forging						1
	1800F Q 500F 1+1HR (0.21C)	Forging						1
	1800F Q 600F 1HR (0.20C)	Forging						1
	1800F Q 650F 1+1HR (0.28C)	Forging						1
	1800F Q 650F 1HR (0.24C)	Forging						1
	1800F Q 700F 1HR (0.21C)	Forging						1
	1800F Q 780F 1+1HR (0.33C)	Forging						1
	1800F Q 800F 1HR (0.46C)	Forging						1
	1800F Q 900F 1HR (0.64C)	Forging						1
	1800F Q 925F 1+1HR (0.53C)	Forging						1
4340 (VAR)	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	8					
4340V	Unspecified	Extrusion					3	

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
A286	1800F 0.5-1.0 HR WQ 1325F 16HR AC	Plate				8		
		Round Bar				3		
AF1410	Unspecified	Forging	10					
	1525F 1HR AC -100F 1HR AC 950F 5HRS AC	Round Bar				12		
	1575 FOR 1HR; -100 FOR 3HR; 925F FOR 6 HR	Forging	1					
	1575 FOR 2HR; -100F FOR 3HR; 925F FOR 6 HR	Forging	1					
	1575F FOR 1HR AIR COOLED; 1575F FOR 1HR; -100F FOR 3HR; 925F 6HR	Forging	1					
	1575F FOR 1HR AIR/FAN COOLED; -100F FOR 3HR; AIR WARMED 925F FOR 5HR	Forging	1					
	1575F FOR 2HR AIR COOLED; -100F FOR 3HR; 925F 6HR	Forging	1					
	1650F 1HR WQ 1500F 1HR WQ 950F 5HR AC	Plate	5					
	1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	Plate	1					
	1650F FOR 2HR AIR COOLED; 1250F FOR 8HR; 1575 FOR 1HR; -100F FOR 3HR; 925F FOR 6 HR	Forging	1					
	1650F FOR 2HR AIR COOLED; 1250F FOR 8HR; 1575F FOR 1HR; -100F FOR 3HR; 925F 6HR	Forging	1					
	AGED AT 900F FOR 5 HOURS	Bar	3					
	AGED AT 925F FOR 5 HOURS	Bar	1					
	AIR QUENCHED	Plate				1		
	OIL QUENCHED	Plate				1		
	REAGED AT 925F FOR 10 HOURS	Forging	1					
		Bar	1					

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
AF1410 (Cont'd)	REAGED AT 925F FOR 7.5 HOURS	Bar	1					
AF1410(VIM-VAR)	1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	Plate				12		
D6AC	1550F 25MIN OQ 850F 1+1 HR	Sheet						2
	1550F AQ 650F 4HR	Sheet						1
	1550F AQ 950F 4HR	Sheet						1
	1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR	Forging	61					
	1650F 1HR FC 1650F 1HR OQ 1025F 2+2HR	Billet	2					
	1650F 1HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	Billet	2					
	1650F 1HR FC TO 960F OQ AT 180F AC 1025F 2+2HR	Forging	3					
	1650F A-BQ AT 975F SQ AT 375F 1000F 2+2HR	Forging				5		
	1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR	Plate				17		
		Forging				1		
	1650F AUS-BAY QUENCH 975F SQ 1000F 2+2HR	Plate	7					
	1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	78					
		Forging	30					
	1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	8					
	1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	103					
		Forging	53					
	1675F AC 1575F OQ 400F 2HR 1100F 2HR (RC 42.5)	Plate	4					

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
D6AC (Cont'd)	1675F AC 1575F OQ 400F 2HR 500F 2HR (RC 50)	Plate	4					
	1675F AC 1575F OQ 400F 2HR 800F 2HR (RC 46.5)	Plate	4					
	1700F 1HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	Billet	3					
	1700F 1HR OC 1025F 2+2HR	Billet	6					
	1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS	Plate				24		
		Forging				10		
	1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2HR	Plate	73					
		Forging	49					
	1725F 1HR AC 1700F 1HR OQ 1000F 1HR 1015F 1HR	Billet	3					
	1725F 1HR AC 1700F 1HR OQ 1025F 2+2HR	Billet	6					
	1725F 1HR AC 1700F 1HR OQ 1100F 2+2HR	Billet	6					
	1725F 1HR AC 1750F 1HR FC TO 960F SQ 350F 0.5HR AC 1025F 22HR	Billet	3					
	HEAT TREATED TO 46 RC HARDNESS	Plate	2					
H11	Unspecified	Unspecified					4	
	1325F 1850F 0.5HR AC 1060F 2+2HR	Sheet						2
	AUSTENIZED & TEMPERED (TYS=220KSI)	Round Bar				6		
	QUENCHED + TEMPERED AT 1100F	Plate						1
HP9-4-.20	Unspecified	Plate						2
		Forging	4			8		2
		Bar				2		

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
HP9-4-.20 (Cont'd)	1525F 2HRS AC -100F 2HRS 1025F 4HRS	Plate				11		
		Billet				22		
	1525F 2HRS OQ -100F 2HRS 1025F 4HRS	Plate						8
		Forged Bar						12
	1525F OQ -100F 1HR 1065F 4+4HR	Forging	2					
	1650F 1-2HR AC 1-2HR 1-2HR AC -100F 1.5HR 1025F 4HR 1060F 4HR	Plate	3					
	1650F 1-2HR AC 1-2HR 1-2HR AC -130F 1.5HR 1025-1075F 4HR	Plate	1					
	1650F 1-2HR AC 1525F 1-2HR AC -100F 1-2HR 1025F 4HR	Forging	2					
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-2HR 1025F 4HR	Forging	8					
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1000F 4-6HR	Forging	1					
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1025F 4-6HR	Plate	10					
		Forging	26					
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1050F 4-6HR	Forging	6					
	1650F 1-2HR ACX	Forging	3					
	1650F 2HR AC 1525F 2HR OQ 1000F 2+2HR AC	Forging	3					
	1650F 4.5HR AC TO 900F HELD 0.5HR AC -100F 1.5HR 1025F 8HR A-BQ	Forging	2					
	1700F 4.5HR AC 1700F 1.5HR AC -100F 1.5HR 1025F 4HR	Forging	2					

TABLE 3.0.1 (CONTINUED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
HP9-4-.20 (Cont'd)	ANNEALED	Forging	15					
	GTA WELD WELDMENT	Plate						1
	HEAT TREATED	Forging	17					
	QUENCHED + TEMPERED	Plate						2
	WELDED	Weldment				3		
HP9-4-.20(CEVM)	ANNEALED	Forging				8		
HP9-4-.25(VAR)	1550F 1HR OQ 1000F 2+2HR AC	Forging	14					
HP9-4-.30	Unspecified	Plate				23		
		Forging	4			8		4
		Bar				3		
	1525F 2HRS OQ -100F 1HR 1025F 2+2HR	Forged Bar				1		
	1525F 2HRS OQ -100F 2HRS 1025F 2+2HR	Forged Bar				2		
	1525F OQ -100F 3HR 1050F 4HR	Forging	1					
	1550F 2HRS OQ -100F 1HR 1025F 2+2HR	Forged Bar				11		
	1550F 2HRS OQ -100F 3HRS 1000F 2+2HRS	Forged Bar				1		
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1000F 4HR	Forging	7					
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1025F 4HR	Forging	3					
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1050F 4HR	Forging	2					
	1650F 2HR AC 1550F 2HR OQ -100F 2HR AC 1000F 4HR AC 1000F 4HR AC	Forging	1					
	1650F 2HR AC 1550F 2HR OQ 1000F 2+2HR AC	Forging	2					

TABLE 3.0.1 (CONCLUDED)

AVAILABLE DATA FOR ALLOY STEELS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
HP9-4-.30 (Cont'd)	1650F AC 1525F 1-2HR OQ -100F 1-3HR 1050F 4HR	Forging	1					
	HEAT TREATED TO 49 RC HARDNESS	Plate	2					
	QUENCHED + TEMPERED AT 950F	Plate						2
	UTS=220-240KSI	Billet				25		
HP9-4-.45	1600F 0.5HR AC 1500F 0.33HR AC	Sheet						2
	475F	Plate						1
HY-150	1500F 1HR WQ	Plate						1
HY-180	STA (UTS=180KSI)	Forged Bar				4		
HY-80	Unspecified	Unspecified				2		
HY-TUF	1700F 1HR AC 1600F 1HR OQ 550F 2HR	Forging	3					
	1700F 1HR AC 1600F 1HR+1000F 20 MIN	Forging	2					

TABLE 3.0.2

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALLOY STEELS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$ Specimen Orientation L-T Min Spec Thk	L-T n	L-T Mean	L-T Std Dev	T-L Min Spec Thk	T-L n	T-L Mean	T-L Std Dev	S-L Min Spec Thk	S-L n	S-L Mean	S-L Std Dev
18NI(200)(MAR)	1650F 4.5 HR AC AGED 1000F 6HR	Plate	4.25	2.40	3	102.3	1.2	---	---	---	---	---	---	---	---
	1650F 4.5 HR AC AGED 900F 24HR	Plate	4.25	2.40	2	96.5	0.7	---	---	---	---	---	---	---	---
	1650F 4.5 HR AC AGED 900F 6HR	Forging	3.00	2.40	3	100.3	0.6	---	---	---	---	---	---	---	---
	1650F 4.5 HR AC AGED 950F 24HR	Plate	4.25	2.40	3	99.3	1.2	---	---	---	---	---	---	---	---
18NI(250)(MAR)	1500F 1HR AC AGED 900F 3HR AC	Billet	1.00-12.00	0.50	7	74.3	4.2	0.50	6	64.1	4.4	---	---	---	---
	1500F AC 850F 6HR	Plate	4.25	1.80	5	76.0	1.9	---	---	---	---	---	---	---	---
	1500F AC 900F 24HR	Plate	2.00	1.80	6	80.7	1.2	---	---	---	---	---	---	---	---
	1500F AC 900F 6HR	Plate	2.00	1.80	6	82.3	3.2	---	---	---	---	---	---	---	---
	1500F AC 950F 6HR	Plate	2.00	1.80	6	84.0	2.6	---	---	---	---	---	---	---	---
300M	Unspecified	Forging	1.25	1.25	4	52.6	2.3	1.25	4	52.9	2.0	---	---	---	---
	1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	0.25	4	54.6	2.5	0.25	2	50.6	1.7	0.25	4	54.1	1.1
	1700F 1HR AC 1600F 1HR OQ 600F 2HR AC (AMS 6419)	Plate	0.56-1.00	0.50	3	51.8	0.7	---	---	---	---	---	---	---	---
	2190F 1HR FC TO 1600F HOLD 0.5HR OQ 475F 1HR	Bar	0.62	0.60	2	47.9	3.8	---	---	---	---	---	---	---	---
	HEAT TREATED TO 54 RC HARDNESS	Plate	1.00	---	---	---	---	0.45	2	58.6	3.5	---	---	---	---

TABLE 3.0.2 (CONTINUED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALLOY STEELS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$											
				Specimen Orientation											
				L-T				T-L				S-L			
				Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev
300M (AM)	1650F 1HR AC 1550F 1HR OQ -320F 0.5HR 600F 2+2HR AC	Forging	4.00	0.90	3	46.5	3.8	---	---	---	---	---	---	---	---
300M (VAR)	1650F 1HR AC 1550F 1HR OQ -320F 0.5HR 600F 2+2HR AC	Forging	4.50	0.90	4	52.2	1.3	---	---	---	---	---	---	---	---
300M (VM)	1500F OQ 400F 2+2HR	Plate	0.56	0.50	2	48.0	17.0	---	---	---	---	---	---	---	---
	1500F OQ 550F 2+2HR	Plate	0.56	0.50	2	49.5	10.6	---	---	---	---	---	---	---	---
	1550F OQ 550F 2+2HR	Plate	0.56	0.50	2	62.5	3.5	---	---	---	---	---	---	---	---
	1700F AC 1600F 1HR OQ 550F 2+2HR	Billet	5.50	---	---	---	---	1.00	3	55.3	0.3	---	---	---	---
	1700F AC 1600F 1HR SQ 400F AC 550F 2+2HR	Billet	5.50	---	---	---	---	1.00	3	58.0	3.4	---	---	---	---
	1700F AC 1600F 1HR SQ 975F OQ 575F 2+2HR	Billet	5.50	---	---	---	---	1.00	3	58.6	2.2	---	---	---	---
4140	1600F 1HR 1550F 1HR OQ AT 150-175F 900F 1HR	Plate	1.00	---	---	---	---	0.99	2	72.0	18.8	---	---	---	---
	2010F 1 HR OQ 475F 1HR	Forged Bar	0.62	0.60	2	52.1	7.4	---	---	---	---	---	---	---	---
	2190F 1 HR OQ 400F 1HR	Forged Bar	0.62	0.60	2	81.1	13.2	---	---	---	---	---	---	---	---
	2190F 1 HR OQ 475F 1HR	Forged Bar	0.62	0.60	2	66.1	2.7	---	---	---	---	---	---	---	---

TABLE 3.0.2 (CONTINUED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALLOY STEELS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$											
				Specimen Orientation											
				L-T				T-L				S-L			
				Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev
4330V (MOD)	1600F 1HR OQ 535F 1HR	Forged Bar	0.62	0.60	2	96.7	3.8	---	---	---	---	---	---	---	---
	1650F 1HR AC 1575F 1HR OQ 800F 2+2HR	Billet	6.00	1.00	9	86.4	7.6	---	---	---	---	---	---	---	---
	HEAT TREATED TO 46 RC HARDNESS	Plate	0.62	---	---	---	---	0.75	2	74.7	0.8	---	---	---	---
4340	1550F OQ TEMPERED 500F	Plate	1.00	0.80	4	45.3	2.9	---	---	---	---	---	---	---	---
	1550F OQ TEMPERED 800F	Plate	1.00	0.80	2	76.6	4.6	---	---	---	---	---	---	---	---
	1600F 1HR 1525F 2.5HR OQ AT 150-175F 900F 1HR	Plate	1.00	---	---	---	---	1.01	2	88.2	1.5	---	---	---	---
	1600F 1HR OQ 535F 1HR	Forged Bar	0.62	0.60	2	60.9	0.8	---	---	---	---	---	---	---	---
	1650F 1HR AC 1525F 1HR OQ 800F 2HR	Billet	10.00	1.00	6	76.3	3.6	---	---	---	---	---	---	---	---
	2190F 1HR FC TO 1600F HOLD 0.5HR 400F 1HR	Forged Bar	0.62	0.60	2	76.8	0.1	---	---	---	---	---	---	---	---
	2190F 1HR FC TO 1600F HOLD 0.5HR 535F 1HR	Forged Bar	0.62	0.60	2	60.1	3.2	---	---	---	---	---	---	---	---
	2190F 1HR FC TO 1600F HOLD 0.5HR 660F 1HR	Forged Bar	0.62	0.60	2	60.8	0.8	---	---	---	---	---	---	---	---
	HEAT TREATED TO 51 RC HARDNESS	Plate	0.62	---	---	---	---	0.50	2	51.7	1.3	---	---	---	---

TABLE 3.0.2 (CONTINUED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALLOY STEELS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} ($Ksi\sqrt{in}$) Specimen Orientation L-T				T-L				S-L			
				Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev
4340 (AM)	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	4.00	0.90	3	40.5	0.5	---	---	---	---	---	---	---	---
4340 (DH)	1550F OQ 900F 1HR	Billet	1.00	---	---	---	---	1.00	4	66.3	6.2	---	---	---	---
	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	4.00	0.90	7	51.0	3.0	---	---	---	---	---	---	---	---
4340 (VAR)	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	4.00	0.90	8	55.0	4.4	---	---	---	---	---	---	---	---
AF1410	Unspecified	Forging	5.75	1.25	6	98.7	11.3	1.25	3	105.6	4.8	---	---	---	---
	1650F 1HR WQ 1500F 1HR WQ 950F 5HR AC	Plate	2.00	1.75	2	139.6	11.7	1.75	2	136.7	7.4	---	---	---	---
D6AC	1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR	Forging	6.50	---	---	---	---	1.00	6	78.4	15.1	0.97	52	83.9	14.8
	1650F 1HR FC 1650F 1HR OQ 1025F 2+2HR	Billet	7.00	1.00	2	78.5	4.7	---	---	---	---	---	---	---	---
	1650F 1HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	Billet	7.00	1.00	2	80.3	0.8	---	---	---	---	---	---	---	---
	1650F AUS-BAY QUENCH 975F SQ 1000F 2+2HR	Plate	0.80-1.50	0.75	7	66.9	18.7	---	---	---	---	---	---	---	---
	1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	0.60	19	62.2	14.0	---	---	---	---	---	---	---	---

TABLE 3.0.2 (CONTINUED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALLOY STEELS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$ Specimen Orientation L-T Min Spec Thk	L-T n	L-T Mean	L-T Std Dev	T-L Min Spec Thk	T-L n	T-L Mean	T-L Std Dev	S-L Min Spec Thk	S-L n	S-L Mean	S-L Std Dev
D6AC (Cont'd)	1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	0.75	8	46.0	4.2	---	---	---	---	---	---	---	---
	1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	0.60	103	64.4	12.1	---	---	---	---	---	---	---	---
		Forging	0.80-1.50	0.60	53	66.2	12.3	---	---	---	---	---	---	---	---
	1700F 1HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	Billet	7.00	1.00	3	80.3	4.3	---	---	---	---	---	---	---	---
	1700F 1HR OC 1025F 2+2HR	Billet	7.00-10.00	1.00	6	77.3	2.6	---	---	---	---	---	---	---	---
	1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2HR	Plate	0.80-1.50	0.61	30	92.0	8.2	---	---	---	---	---	---	---	---
		Forging	0.80-1.50	0.75	34	95.2	6.4	---	---	---	---	---	---	---	---
	1725F 1HR AC 1700F 1HR OQ 1000F 1HR 1015F 1HR	Billet	7.00	1.00	3	77.2	2.7	---	---	---	---	---	---	---	---
	1725F 1HR AC 1700F 1HR OQ 1025F 2+2HR	Billet	7.00-10.00	1.00	6	74.4	6.2	---	---	---	---	---	---	---	---
	1725F 1HR AC 1700F 1HR OQ 1100F 2+2HR	Billet	7.00-10.00	1.00	6	101.2	6.1	---	---	---	---	---	---	---	---
	1725F 1HR AC 1750F 1HR FC TO 960F SQ 350F 0.5HR AC 1025F 22HR	Billet	7.00	1.00	3	75.1	10.1	---	---	---	---	---	---	---	---
	HEAT TREATED TO 46 RC HARDNESS	Plate	---	---	---	---	---	0.70	2	85.8	1.8	---	---	---	---

TABLE 3.0.2 (CONTINUED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALLOY STEELS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$ Specimen Orientation L-T Min Spec Thk	L-T n	L-T Mean	L-T Std Dev	T-L Min Spec Thk	T-L n	T-L Mean	T-L Std Dev	S-L Min Spec Thk	S-L n	S-L Mean	S-L Std Dev
HP9-4-.20	Unspecified	Forging	1.25	2.00	2	150.6	4.5	2.00	2	136.3	16.8	---	---	---	---
	1525F OQ -100F 1HR 1065F 4+4HR	Forging	4.00	---	---	---	---	1.50	2	111.7	2.0	---	---	---	---
	1650F 1-2HR AC 1-2HR 1-2HR AC -100F 1.5HR 1025F 4HR 1060F 4HR	Plate	2.50	2.00	2	123.5	12.0	---	---	---	---	---	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-2HR 1025F 4HR	Forging	4.00-7.00	1.75	5	134.8	12.3	1.76	3	109.7	4.7	---	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1025F 4-6HR	Plate	2.50	2.00	2	121.5	29.0	---	---	---	---	---	---	---	---
		Forging	4.00	1.51	15	135.2	11.6	1.51	6	125.3	1.8	---	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1050F 4-6HR	Forging	1.70-3.25	1.50	5	133.2	3.9	---	---	---	---	---	---	---	---
	1650F 1-2HR ACX	Forging	4.00	1.55	2	125.5	3.5	---	---	---	---	---	---	---	---
	1650F 2HR AC 1525F 2HR OQ 1000F 2+2HR AC	Forging	4.00	1.24	3	94.4	4.4	---	---	---	---	---	---	---	---
	1650F 4.5HR AC TO 900F HELD 0.5HR AC -100F 1.5HR 1025F 8HR A-BQ	Forging	4.00	1.59	2	128.5	0.7	---	---	---	---	---	---	---	---
	1700F 4.5HR AC 1700F 1.5HR AC -100F 1.5HR 1025F 4HR	Forging	4.00	1.60	2	140.5	0.7	---	---	---	---	---	---	---	---
	ANNEALED	Forging	3.00	1.00	12	120.6	7.3	2.00	3	117.7	1.9	---	---	---	---
	HEAT TREATED	Forging	3.40-7.00	1.50	10	140.7	4.5	1.46	7	132.3	6.6	---	---	---	---

TABLE 3.0.2 (CONCLUDED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF ALLOY STEELS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$											
				Specimen Orientation											
				L-T				T-L				S-L			
				Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev
HP9-4-.25(VAR)	1550F 1HR OQ 1000F 2+2HR AC	Forging	3.00	---	---	---	---	2.00	2	98.9	4.5	---	---	---	---
HP9-4-.30	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1000F 4HR	Forging	3.00	1.00	2	106.0	1.4	1.00	3	89.0	3.0	---	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1025F 4HR	Forging	3.00	---	---	---	---	1.00	2	93.5	0.7	---	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1050F 4HR	Forging	3.00	---	---	---	---	1.00	2	87.6	0.8	---	---	---	---
	1650F 2HR AC 1550F 2HR OQ 1000F 2+2HR AC	Forging	3.25	2.02	2	82.0	0.0	---	---	---	---	---	---	---	---
	HEAT TREATED TO 49 RC HARDNESS	Plate	3.25	---	---	---	---	1.01	2	82.5	5.0	---	---	---	---
HY-TUF	1700F 1HR AC 1600F 1HR OQ 550F 2HR	Forging	6.50	---	---	---	---	1.00	2	111.5	2.1	---	---	---	---

TABLE 3.0.3

PLANE STRESS AND TRANSITIONAL FRACTURE TOUGHNESS OF ALLOY STEELS (WITHOUT BUCKLING CONSTRAINTS)

Alloy	Condition/ Heat Treatment	Test Temp (°F)	Specimen		Yield Strength (Ksi)	K_c ($Ksi\sqrt{in}$) Specimen Thickness (in.) n - Sample size μ - Mean σ - Standard Deviation											
			Orient	Width (in.)		0.025			0.1			0.125			0.2		
						n	μ	σ	n	μ	σ	n	μ	σ	n	μ	σ
18NI(300)(MAR)	Unspecified	-423.	L-T	4.0	86.0	5	86.4	7.2									
		-320.	L-T	2.0	36.0	5	142.5	7.3									
				4.0	36.0	5	124.2	8.0									
		R.T.	L-T	2.0	77.0	5	132.1	4.3									
				4.0	77.0	5	128.4	3.8									
				18.0	77.0	4	109.8	8.9									

TABLE 3.0.4.1

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR ALLOY STEELS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: UNSPECIFIED **STRESS RATIO: 0.08** **FREQUENCY: 1 - 30 Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) *ΔK Level (Ksi√in)*					
					2.5	5.0	10.0	20.0	50.0	100.0
AF1410	AIR QUENCHED	PLATE	0.08	10-30				4.2	37.13	
	OIL QUENCHED	PLATE	0.08	1-30				4.4	31	

TABLE 3.0.4.2

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR ALLOY STEELS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: L-T **STRESS RATIO: -1.0 - 0.8** **FREQUENCY: 0.1 - 30. Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
12-9-2 MAR	STA 900	ROUND BAR	0.1	10				8.17		
			0.1	30			0.15	8.92		
300M	UTS=280-300KSI	BAR	-1	10				3.65	38.07	
			0.02	10				3.52	47.71	
			0.5	10			1	6.55		
	UNSPECIFIED	FORGING	0.02	1-15			0.66	4.24		
			0.02	0.1-20			0.67	4.26	104.94	
4330V (MOD)	UNSPECIFIED	BILLET	0.02	1-30			1.98	7.29	27.92	
4340	MARTEMPERED	PLATE	0.02				0.52	3.06	22.96	115.4
	UTS=150KSI	FORGING	0.1	30		0.02	0.28	2.44		
		UNSPECIFIED	-0.1	2-5			0.44			
	UTS=160KSI	ROUND BAR	0.1	7				2.47		
			0.5	7			0.61	3.6		
			0.5	7		0.09				
	UTS=160-180KSI	BAR	0.1	20				2.69	30.66	
			0.5	20		0.09	0.64	3.9	34.11	
			0.8	20			0.68	4.16		

TABLE 3.0.4.2 (CONTINUED)

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR ALLOY STEELS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: L-T **STRESS RATIO: -1.0 - 0.8** **FREQUENCY: 0.1 - 30. Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in)					
					2.5	5.0	10.0	20.0	50.0	100.0
4340 (Cont'd)	UTS=180KSI	FORGING	0.1	20-30		0.02	0.35	2.52		
			0.5	30		0.08	0.58	3.4		
		ROUND BAR	0.1	20				2.89	23.41	
			0.1	30			0.42			
			0.5	7		0.09				
			0.5	7			0.65			
A286	1800F 0.5-1.0 HR WQ 1325F 16HR AC	PLATE	0.05	3				1.59	31.48	
AF1410	1525F 1HR AC -100F 1HR AC 950F 5HRS AC	ROUND BAR	0.02	0.1-30		0.11	0.64	3.6	32.69	151.39
AF1410(VIM-VAR)	1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	PLATE	0.08	30			0.65	3.88	27.26	
D6AC	1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR	PLATE	0.1	0.1					65.2	
			0.1	1				2.85		
			0.5	1				9.29		
	1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS	PLATE	0.1	1				5.61	51.35	

TABLE 3.0.4.2 (CONCLUDED)

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR ALLOY STEELS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: L-T **STRESS RATIO: -1.0 - 0.8** **FREQUENCY: 0.1 - 30. Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in)					
					2.5	5.0	10.0	20.0	50.0	100.0
H11	AUSTENIZED & TEMPERED (TYS=220KSI)	ROUND BAR	0.1	10				3.53		
			0.1	30			0.34	2.95		
			0.5	10				4.94		
			0.5	30		0.09	0.72	4.93		
HP9-4-.20	UNSPECIFIED	FORGING	0.02	0.1-20			0.18	1.61	18.9	125.87
		BAR	0.02	10				3.58	33.15	
HP9-4-.20(CEVM)	ANNEALED	FORGING	0.1	5-10				6.33	37.05	
HP9-4-.30	UNSPECIFIED	FORGING	0.02	5-20			0.41	2.97	37.38	
		BAR	0.02	1					46.37	
			0.02	10				3.59	46.57	
HY-180	STA (UTS=180KSI)	FORGED BAR	0.1	10				4.29	30.82	
			0.1	30		0.11	0.48	3.72		
			0.5	10				5.61		
			0.5	30		0.11	0.53	4.5		

TABLE 3.0.4.3

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR ALLOY STEELS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: T-L **STRESS RATIO: 0.02 - 0.3** **FREQUENCY: 0.1 - 30. Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in)					
					2.5	5.0	10.0	20.0	50.0	100.0
18NI(250)MAR	UTS=243KSI	BILLET	0.1	10			1.16	5.91	71.03	
300M	UNSPECIFIED	FORGING	0.02	0.1-20		0.14	0.7	4.35	156.19	
A286	1800F 0.5-1.0 HR WQ 1325F 16HR AC	PLATE	0.05	3				1.82		
AF1410	1525F 1HR AC -100F 1HR AC 950F 5HRS AC	ROUND BAR	0.02	0.1-30		0.11	0.68	3.64	31.7	172.61
AF1410(VIM-VAR)	1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	PLATE	0.08	1-30			0.71	3.95	29.34	
			0.08	1-30			0.71	3.95	29.34	
			0.3	10-30			1.11	5.35	36.14	
			0.3	10-30			1.11	5.35	36.14	
HP9-4-.20	UNSPECIFIED	FORGING	0.02	0.1-20			0.24	2.99	30.69	489.57
HP9-4-.30	UNSPECIFIED	FORGING	0.02	0.1-20			0.46	3.14	49.14	1733.09

TABLE 3.0.5

STRESS CORROSION CRACKING THRESHOLD DATA FOR STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in.})$ ENVIRONMENTS: SIMULATED SEA WATER	SEA WATER	DISTILLED WATER	3.5 % NACL	SUMP TANK WATER
D6AC	1550F AQ 650F 4HR	Sheet	L-T			7.0		
	1550F AQ 950F 4HR	Sheet	L-T			45.2		
HP9-4-.20	GTA Weld	Plate	---	65.0				
	Quenched and Tempered	Plate	---				110.0(2)	
	1525F 2HR OQ -100F 2HR 1025F 4HR	Plate	L-T					105.0(3)
			T-L					97.4(5)
		Forged Bar	L-T					110.0
			T-L					107.0(2)
			S-T					78.3(3)
HP9-4-.45	475F	Plate	---				20.0	
H-11	Quenched and Tempered at 1100F	Plate	---				30.0	
12Ni-5Cr-3Mo	Electric Furnace	Plate	---	40.0				
	GTA Welded	Weldment	---	33.0				
	Low Residual	Plate	---	108.0				
	1550F, 900F 20HR AC	Plate	L-S				80.0	
			T-S				70.0	

TABLE 3.0.5 (CONTINUED)

STRESS CORROSION CRACKING THRESHOLD DATA FOR STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in.})$ ENVIRONMENTS: SIMULATED SEA WATER	SEA WATER	DISTILLED WATER	3.5 % NACL	SUMP TANK WATER
18Ni(180)(MAR)	TYS = 178 KSI	Plate	---	108.0				
	TYS = 195 KSI	Plate	---				60.0	
	TYS = 200 KSI	Plate	---				105.0	
18Ni(200)(MAR)	TYS = 215 KSI	Plate	---				70.0	
	Weld Center Line	Plate	L-S				70.0	
	1500F 1HR AC 900F 3HR	Plate	T-S				39.0	
	1675F 2HR AC	Plate	T-S				48.0	
	500F 0.25HR 850F 4HR/cool 250F/min	Weldment	T-S				78.0	
18Ni(250)(MAR)	AGE 900F 3HR AC	Plate	L-S				40.5(2)	
			L-T				45.0	
	TYS = 250 KSI	Plate	---				50.0	
	TYS = 260 KSI	Plate	---				70.0	
	1650F 1.25HR WQ 1525F 1.25 HR WQ 900F 3HR AC	Plate		36.7				
18Ni(280)(MAR)	1500F 1HR AC 900F 3HR	Plate	---				14.0	

TABLE 3.0.5 (CONTINUED)

STRESS CORROSION CRACKING THRESHOLD DATA FOR STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in.})$ ENVIRONMENTS: SIMULATED SEA WATER	SEA WATER	DISTILLED WATER	3.5 % NACL	SUMP TANK WATER
18Ni(300)(MAR)	AGED 900F 6HR	Forging	L-T				7.0	
			T-L				6.0(2)	
	AGED 950F 12HR	Forging	T-L				6.0	
	Crack Prestressed to 50 PCT KIC	Forging	T-L				5.0	
	Crack Prestressed to 25 PCT KIC	Forging	T-L				5.0	
	Crack Prestressed to 80 PCT KIC	Forging	T-L				10.0	
	1500F 0.5HR AC 900F 3HR	Plate	L-S			48.0(2)		
	1500F 2HR 800F 10 HR	Bar	L-S			9.0		
	1700F, 1500F AGED 900F 6HR	Forging	T-L				7.5	
	900F 3HR 950F 3HR	Forging	T-L				5.0	
18Ni(350)(MAR)	AGE 800F 8HR	Forged Bar	---				5.0	
	AGE 900F 3HR	Forged Bar	---				10.0	
	AGE 900F 8HR	Forged Bar	---				10.0	
	1500F 1HR 800F 8HR	Forging	L-S				5.0	
	1500F 1HR 900F 8HR	Forging	L-S				10.0	
	1500F 1HR 950F 3HR	Forging	L-S				10.0	

TABLE 3.0.5 (CONTINUED)

STRESS CORROSION CRACKING THRESHOLD DATA FOR STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in.})$ ENVIRONMENTS: SIMULATED SEA WATER	SEA WATER	DISTILLED WATER	3.5 % NACL	SUMP TANK WATER
300M	1500F 0.5HR OQ 400F 2+2HR (Coarse Grain)	Plate	---				12.0	
	1500F 0.5HR OQ 400F 2+2HR (Fine Grain)	Plate	---				12.0	
	1500F 0.5HR OQ 550F 2+2HR (Coarse Grain)	Plate	---				15.0	
	1500F 0.5HR OQ 550F 2+2HR (Fine Grain)	Plate	---				15.0	
	1550F 0.5HR OQ 400F 2+2HR (Coarse Grain)	Plate	---				15.0	
	1550F 0.5HR OQ 400F 2+2HR (Fine Grain)	Plate	---				15.0	
	1550F 0.5HR OQ 550F 2+2HR (Coarse Grain)	Plate	---				15.0	
	1550F 0.5HR OQ 550F 2+2HR (Fine Grain)	Plate	---				15.0	
	1600F 0.5HR OQ 400F 2+2HR (Coarse Grain)	Plate	---				12.0	
	1600F 0.5HR OQ 550F 2+2HR (Coarse Grain)	Plate	---				12.0	
	1600F 0.5HR OQ 550F 2+2HR (Fine Grain)	Plate	---				12.0	
	1650F, 1600F 1HR OQ 600F 1+1HR	Forging	L-S				19.6	
	1700F 1.5HR AC 1600F 1.5HR OQ 600F 2+2HR	Forging	S-L					15.5(2)
	1710F, 1610F 610F	Bar	L-T				17.4(3)	
			T-L				17.6(4)	
4140	1700F 1600F OQ 750 1+1HR	Plate	---			15.0		
	1700F 1600F OQ 600F 1+1HR	Plate	---			11.0		

TABLE 3.0.5 (CONTINUED)

STRESS CORROSION CRACKING THRESHOLD DATA FOR STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in.})$ ENVIRONMENTS				
				SIMULATED SEA WATER	SEA WATER	DISTILLED WATER	3.5 % NACL	SUMP TANK WATER
4330V	Quenched and Tempered at 500F	Plate	L-S				25.0	
4340	TYS = 150 KSI	Plate	T-L		59.0			
	TYS = 175 KSI	Plate	T-L		27.0			
	TYS = 200 KSI	Plate	T-L		10.0			
	TYS = 225 KSI	Plate	T-L		5.0			
	1350F OQ 750F 1.25HR	Plate	T-S		8.5			
	1550F OQ 750F Crack Prestressed to 80 PCT K_{Ic}	Plate	---				24.0	
	1550F OQ 750F Crack Prestressed to 60 PCT K_{Ic}	Plate	---				23.0	
	1550F OQ 750F Crack Prestressed to 40 PCT K_{Ic}	Plate	---				17.0	
	1550F OQ 750F Crack Prestressed to 20 PCT K_{Ic}	Plate	---				12.0	
	1550F OQ 750F 1HR	Plate	---				8.0	
	1575F OQ 675F 4HR	Plate	---			9.8		
	1575F OQ 800F 4HR	Plate	---			9.8		
	1600F 1 HR OQ 600F 1+1HR	Forging	---				10.0	
	1650F 1HR AC 1680F 2HR OQ LN 0.25HR 400F 1+1HR OQ	Bar	L-T				15.0	
	1650F 1HR AC 1480F 2HR OQ LN 0.25HR 400F 1+1HR OQ	Bar	L-T				15.0	
	1700F 0.25HR AC 1550F OQ 600F 1+1HR	Sheet	---				29.0	
	1800F Q 600F 1+1HR	Forging	L-S				25.2(12)	

TABLE 3.0.5 (CONCLUDED)

STRESS CORROSION CRACKING THRESHOLD DATA FOR STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in.})$ ENVIRONMENTS				
				SIMULATED SEA WATER	SEA WATER	DISTILLED WATER	3.5 % NACL	SUMP TANK WATER
4340 MOD	1650F 1HR 1600F 1HR OQ 1+1 600F (0.09 SI)	Bar	T-L				18.0	
	1650F 1HR 1600F 1HR OQ 1+1 400F (0.09 SI)	Bar	T-L				13.0	
	1800F Q 460F 1+1HR (0.20C)	Forging	L-S				56.0	
	1800F Q 500F 1+1HR (0.21C)	Forging	L-S				52.0	
	1800F Q 600F 1HR (0.20C)	Forging	L-S				72.0	
	1800F Q 650F 1HR (0.24C)	Forging	L-S				62.0	
	1800F Q 650F 1HR (0.28C)	Forging	L-S				35.0	
	1800F Q 700F 1HR (0.21C)	Forging	L-S				42.0	
	1800F Q 780F 1+1HR (0.33C)	Forging	L-S				32.0	
	1800F Q 800F 1HR (0.46C)	Forging	L-S				20.0	
	1800F Q 900F 1HR (0.64C)	Forging	L-S				30.0	
	1800F Q 925F 1+1HR (0.53C)	Forging	L-S				42.0	

TABLE 3.1.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 10NI STEEL AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Dry Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.1	6			0.45	3.9	25.18	
		0.1	6				5.2	22.92	
		0.3	6			0.8	5.21		
		0.5	6		0.12	0.88	5.02		
		0.7	6		0.13	0.84	5.73		

TABLE 3.1.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 10NI STEEL AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.1	0.1					49.13	
		0.1	1			0.11	2.92	40.39	
		0.5	0.1			1.53	13.72	77.81	
		0.5	1			0.47	7.31	37.14	

TABLE 3.1.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
10NI STEEL AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.1	1				2.21	33.03	131.22

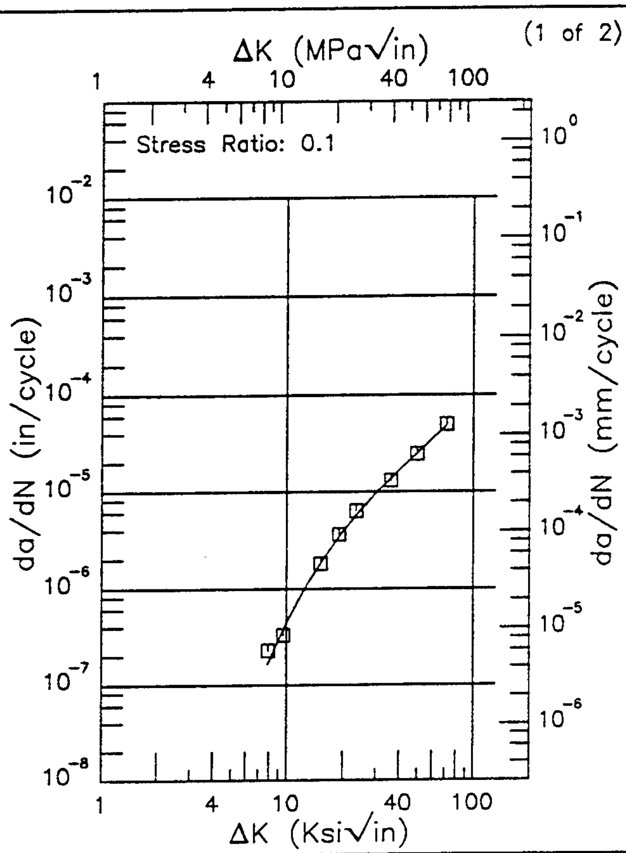
R

10NI STEEL

Condition/Ht:
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: L–T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 183.3 ksi
Ult. Strength: 197.4 ksi
Specimen Thk: 0.494 in.
Specimen Width: 2.494 – 2.496 in.
Ref: 88575

(1 of 2)



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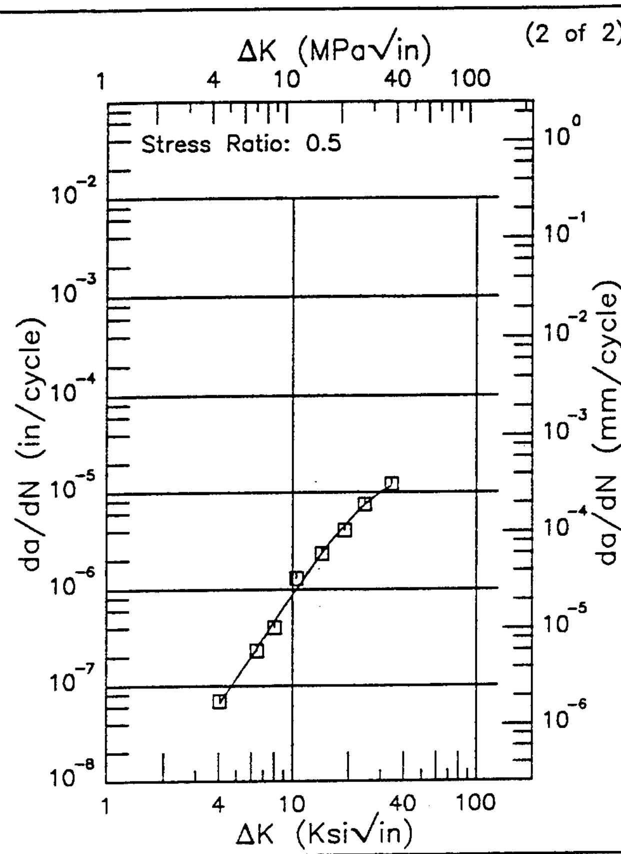


ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
7.88 (min)	0.165
8.	0.177
9.	0.294
10.	0.449
13.	1.14
16.	2.15
20.	3.90
25.	6.57
30.	9.64
35.	13.1
40.	16.8
50.	25.2
60.	35.0
70.	46.6
71.09 (max)	48.0

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
4.05 (min)	0.0661
5.	0.118
6.	0.199
7.	0.313
8.	0.462
9.	0.650
10.	0.878
13.	1.80
16.	3.04
20.	5.02
25.	7.64
30.	10.0
34.16 (max)	11.6

RMS % Error	Life Prediction Ratio Summary
14.25	0. .5 .8 1.25 2.

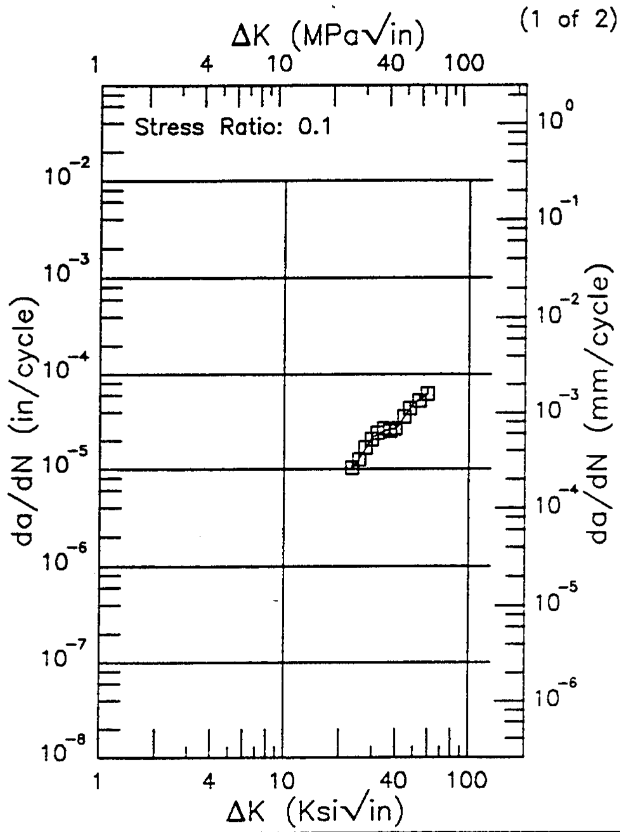
RMS % Error	Life Prediction Ratio Summary
12.30	0. .5 .8 1.25 2.

Figure 3.1.3.1.1

Condition/Ht:
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: L–T
Frequency: 0.1 Hz
Environment: S.T.W.; RT

Yield Strength: 183.3 ksi
Ult. Strength: 197.4 ksi
Specimen Thk: 0.497 – 0.516 in.
Specimen Width: 2.497 – 2.498 in.
Ref: 88575

(1 of 2)



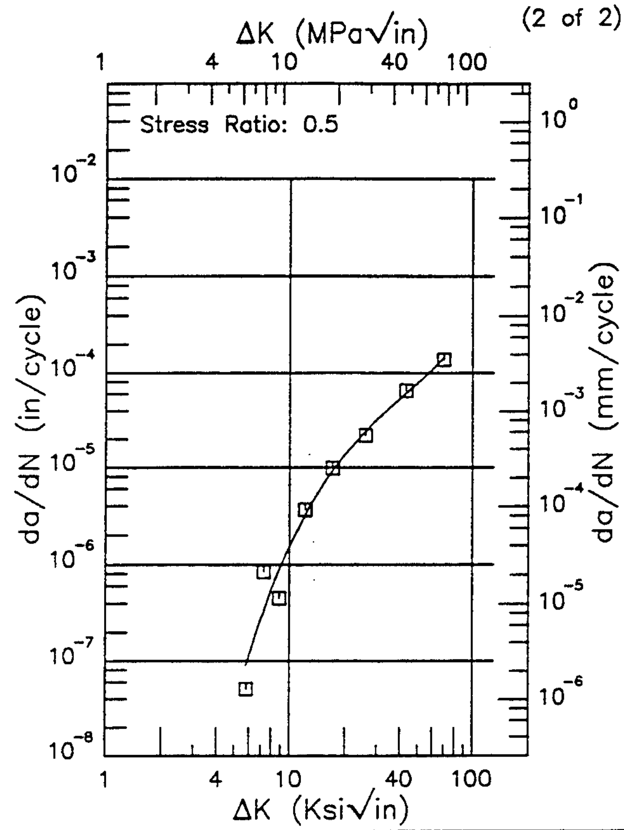
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
23.16 (min)	10.1
25.	12.1
30.	21.4
35.	25.6
40.	26.8
50.	49.1
59.08 (max)	61.0

RMS % Error 2.54

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.79 (min)	0.0903
6.	0.113
7.	0.276
8.	0.555
9.	0.968
10.	1.53
13.	4.06
16.	7.70
20.	13.7
25.	22.4
30.	31.9
35.	42.1
40.	53.1
50.	77.8
60.	108.
69.37 (max)	142.

RMS % Error 60.91

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.1.3.1.2

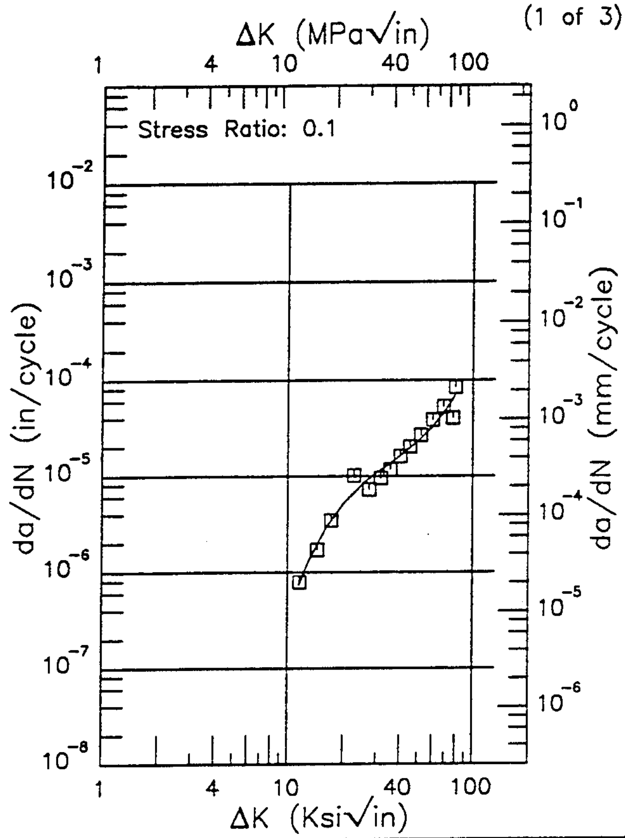
10NI STEEL

R

Condition/Ht:
Form: 1 in. Plate
Specimen Type: CT
Orientation: L–T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 183.3 ksi
Ult. Strength: 197.4 ksi
Specimen Thk: 0.754 in.
Specimen Width: 4.951 – 4.998 in.
Ref: 88575

(1 of 3)



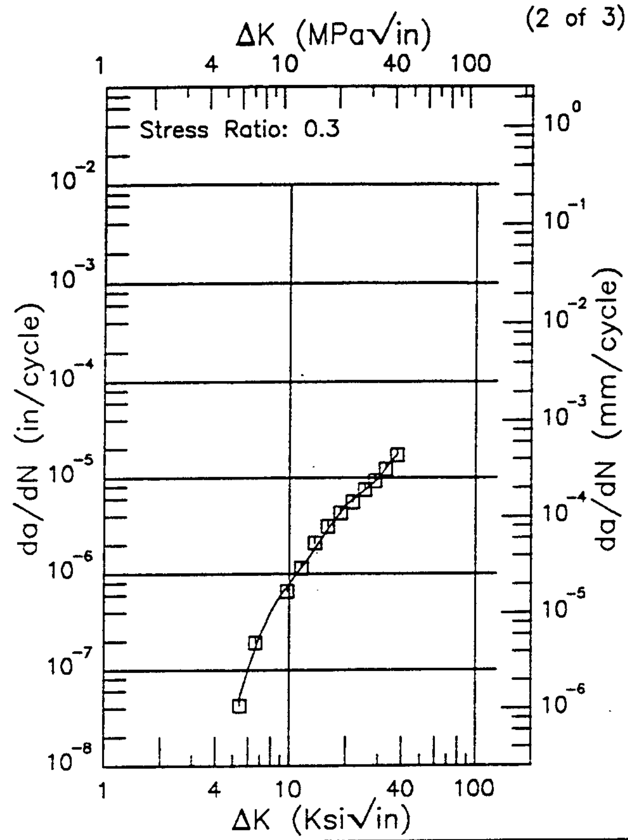
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.50 (min)	0.739
13.	1.31
16.	2.82
20.	5.20
25.	8.14
30.	10.9
35.	13.5
40.	16.2
50.	22.9
60.	32.6
70.	47.4
79.57 (max)	69.3

RMS % Error 21.28

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.39 (min)	0.0476
6.	0.101
7.	0.234
8.	0.405
9.	0.595
10.	0.797
13.	1.55
16.	2.85
20.	5.21
25.	7.26
30.	9.76
35.	14.8
37.57 (max)	17.0

RMS % Error 8.50

Life Prediction Ratio Summary

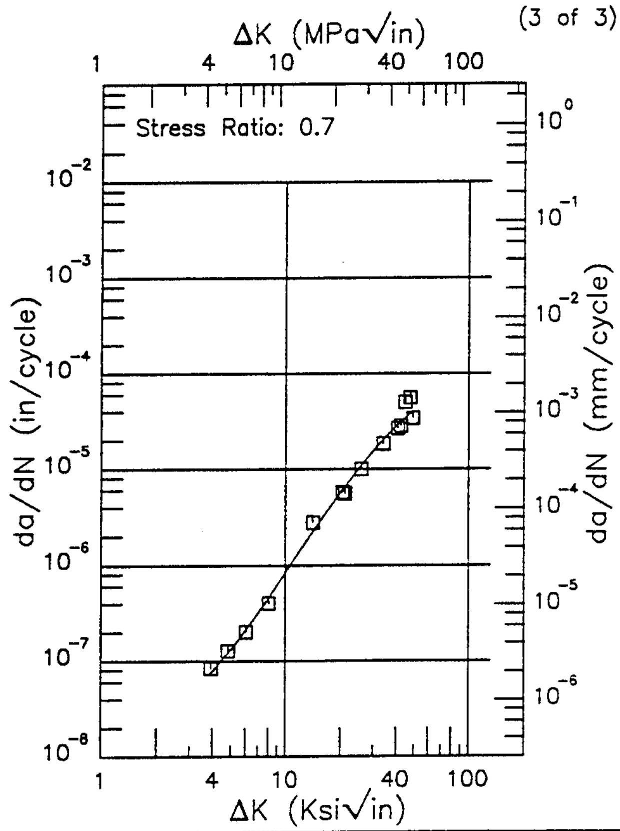
0. .5 .8 1.25 2.

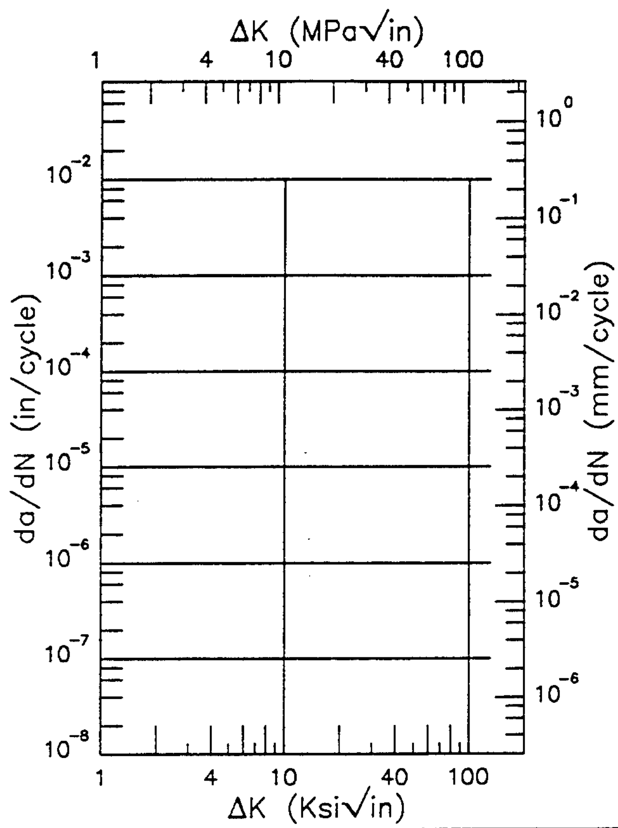
Figure 3.1.3.1.3

Condition/Ht:
Form: 1 in. Plate
Specimen Type: CT
Orientation: L–T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 183.3 ksi
Ult. Strength: 197.4 ksi
Specimen Thk: 0.754 in.
Specimen Width: 4.951 – 4.998 in.
Ref: 88575

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.91 (min)	0.0748
4.	0.0787
5.	0.132
6.	0.210
7.	0.315
8.	0.454
9.	0.628
10.	0.844
13.	1.76
16.	3.14
20.	5.73
25.	10.1
30.	15.5
35.	21.8
40.	28.4
48.99 (max)	40.5

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
20.42

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

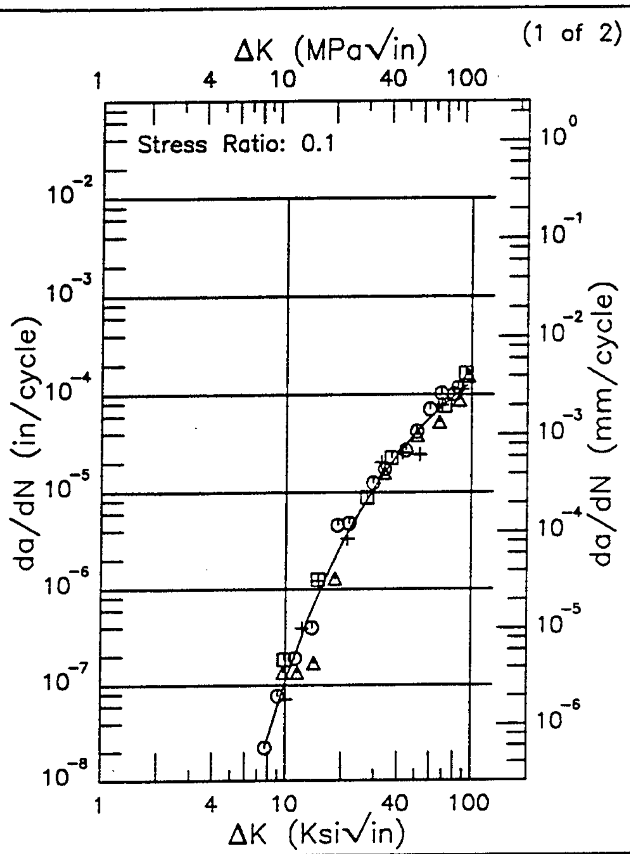
Figure 3.1.3.1.3 (Concluded)

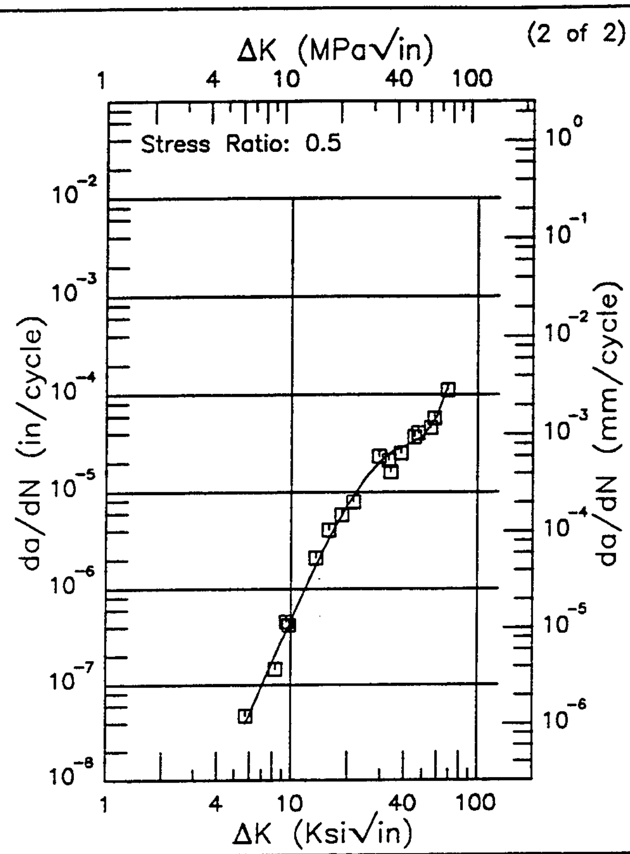
R

10NI STEEL

Condition/Ht:
Form: 1 in. Plate
Specimen Type: CT
Orientation: L–T
Frequency: 1 Hz
Environment: S.T.W.; RT

Yield Strength: 183.3 ksi
Ult. Strength: 197.4 ksi
Specimen Thk: 0.75 – 0.757 in.
Specimen Width: 4.993 – 5.014 in.
Ref: 88575





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.72 (min)	0.0225
8.	0.0284
9.	0.0595
10.	0.111
13.	0.449
16.	1.18
20.	2.92
25.	6.43
30.	11.3
35.	17.4
40.	24.4
50.	40.4
60.	58.1
70.	76.8
80.	96.1
90.	116.
95.02 (max)	126.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.73 (min)	0.0405
6.	0.0493
7.	0.0964
8.	0.174
9.	0.295
10.	0.471
13.	1.45
16.	3.32
20.	7.31
25.	14.0
30.	20.9
35.	26.5
40.	29.9
50.	37.1
60.	60.6
68.00 (max)	116.

RMS % Error	Life Prediction Ratio Summary
34.75	0. .5 .8 1.25 2.

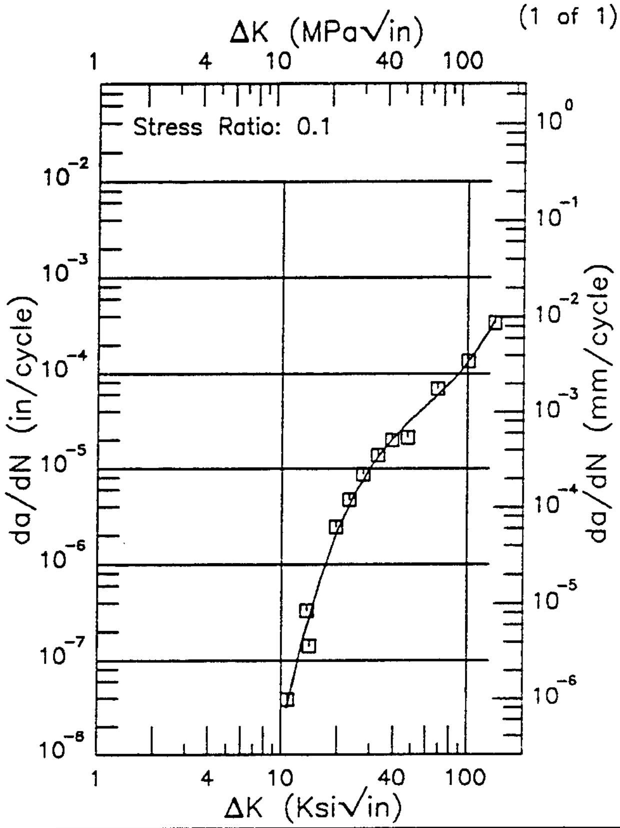
RMS % Error	Life Prediction Ratio Summary
17.14	0. .5 .8 1.25 2.

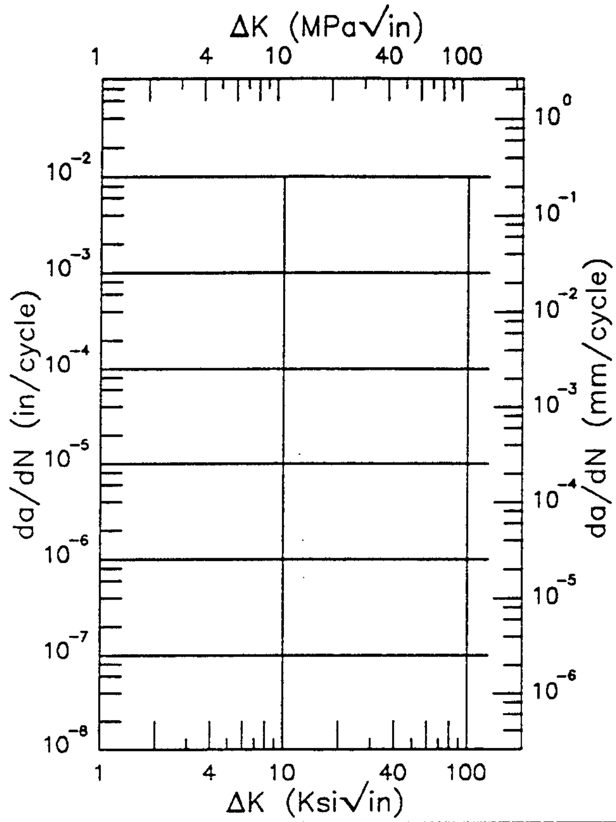
Figure 3.1.3.1.4

Condition/Ht:
Form: 1 in. Plate
Specimen Type: CT
Orientation: T–L
Frequency: 1 Hz
Environment: S.T.W.; RT

Yield Strength: 183.3 ksi
Ult. Strength: 197.4 ksi
Specimen Thk: 0.755 in.
Specimen Width: 5.001 in.
Ref: 88575

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.71 (min)	0.0314
13.	0.160
16.	0.661
20.	2.21
25.	5.63
30.	10.3
35.	15.5
40.	21.2
50.	33.0
60.	46.0
70.	60.9
80.	79.1
90.	102.
100.	131.
130.	285.
138.84 (max)	360.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
25.30	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.1.3.1.5

TABLE 3.2.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 12-9-2 MAR AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) *ΔK Level (Ksi√in)*					
				2.5	5.0	10.0	20.0	50.0	100.0
STA 900	ROUND BAR	0.1	10				8.17		
		0.1	30			0.15	8.92		

TABLE 3.2.2.1

ALLOY STEEL 12-9-2 (MAR) K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi $\cdot$ $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
STA 900	Round Bar	3.00	R.T.	L-T	251.3	2.005	0.958	CT	0.942	0.03	29.60	—	—	1979	DA001

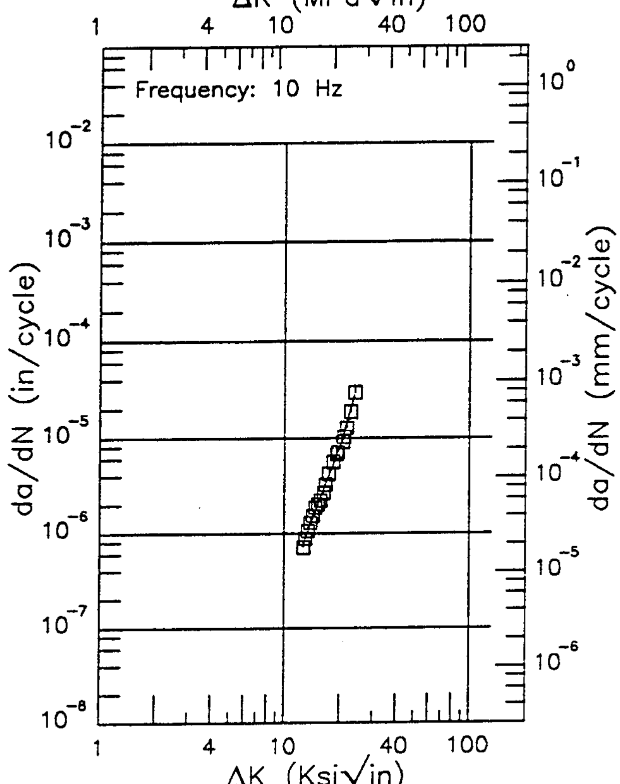
F

12-9-2 MAR

Condition/Ht: STA 900
Form: 3 in. Round Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.1
Environment: LAB AIR; RT

Yield Strength: 251.3 ksi
Ult. Strength: 257.3 ksi
Specimen Thk: 0.253 – 0.503 in.
Specimen Width: 1.99 – 1.991 in.
Ref: DA001

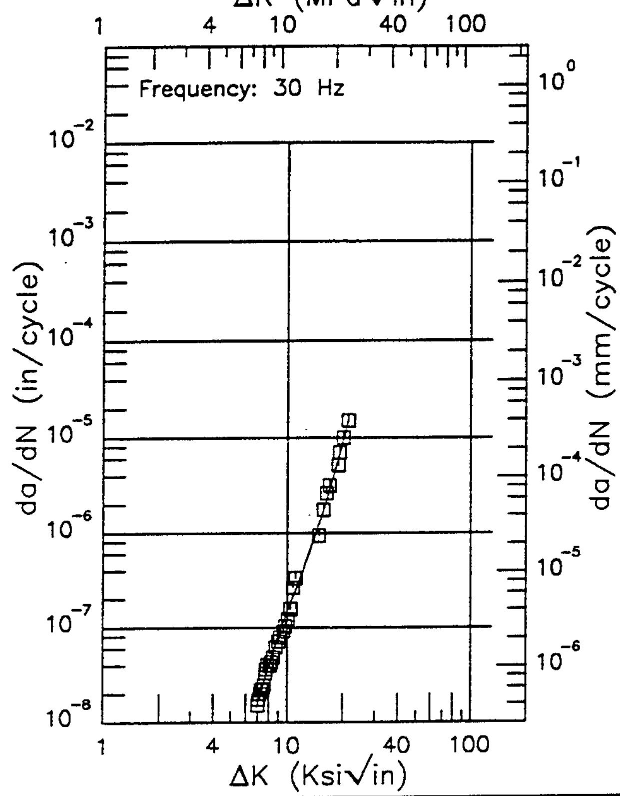
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.68 (min)	0.730
13.	0.863
16.	2.68
20.	8.17
23.91 (max)	27.8

RMS % Error	Life Prediction Ratio Summary
6.90	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.95 (min)	0.0146
7.	0.0155
8.	0.0401
9.	0.0830
10.	0.149
13.	0.581
16.	1.86
20.	8.92
21.41 (max)	15.9

RMS % Error	Life Prediction Ratio Summary
14.62	0. .5 .8 1.25 2.

Figure 3.2.3.1

TABLE 3.3.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 12Ni-5Cr-3Mo

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
Unspecified	---	R.T.	---	---	Syn. Seawater	CANT	---	---	---	---	---	38	---	1969	74232
				184	Syn. Seawater	---	---	---	---	---	---	50	---	1969	74232
Unspecified			T-S	185	3.5% NaCl	CANT	---	---	---	---	135	83	4800	1967	70887
Unspecified	P	R.T.	---	185	3.5% NaCl	WOL*	3.2	1	1	1.52	95.8	43.6	---	1969	84317
						CANT*	---	---	1	---	138	44	---	1969	84317
				190	3.5% NaCl	WOL*	3.2	1	1	1.52	85	52	---	1969	84317
						CANT*	---	---	1	---	123	50	---	1969	84317
1500°F 900°F 20hr AC	P	R.T.	L-S	176	3.5% NaCl	CANT*	2.5	0.5	1	---	249	80	---	1970	84342
			T-S	176	3.5% NaCl	CANT*	2.5	0.5	1	---	246	70	---	1970	84342
Electric Furnace	P	R.T.	---	176	Syn. Seawater	CANT*	1	1	1	---	130	40	60000	1966	65166
GTA Welded	W	R.T.	---	178	Syn. Seawater	---	---	---	---	---	---	33	---	1969	74232
Low-residual	P	R.T.	---	183	Syn. Seawater	CANT*	1	1	1	---	169	108	60000	1966	65166
TYS=150.0KSI	P	R.T.	---	150	3.5% NaCl	CANT*	---	1	1	---	150	130⁺	---	1972	83613
TYS=160.0KSI	P	R.T.	---	160	3.5% NaCl	CANT*	---	1	1	---	205	130⁺	---	1972	83613
TYS=170.0KSI	P	R.T.	---	170	3.5% NaCl	CANT*	---	1	1	---	155	110⁺	---	1972	83613
TYS=175.0KSI	P	R.T.	---	175	3.5% NaCl	CANT*	---	1	1	---	140	105	---	1972	83613

⁺ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.4.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(180)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1500°F 1hr AC 900°F 3hr	P	R.T.	T-S	177	Seawater	CANT	---	---	---	---	---	143⁺	---	1971	81004
					3.5% NaCl	CANT	---	---	1	---	---	130⁺	30000	1971	81004
TYS=170Ksi	P	R.T.	---	170	3.5% NaCl	CANT*	---	1	1	---	160	140⁺	---	1972	83613
TYS=175Ksi	P	R.T.	---	175	3.5% NaCl	CANT*	---	1	1	---	160	125⁺	---	1972	83613
TYS=178Ksi	P	R.T.	---	178	Synth. Seawater	CANT*	1	1	1	---	118	108	60000	1966	65166
TYS=185Ksi	P	R.T.	---	185	3.5% NaCl	CANT*	---	1	1	---	180	130⁺	---	1972	83613
TYS=190Ksi	P	R.T.	---	190	3.5% NaCl	CANT*	---	1	1	---	170	120	---	1972	83613
TYS=195Ksi	P	R.T.	---	195	3.5% NaCl	CANT*	---	1	1	---	165	60	---	1972	83613
TYS=200Ksi	P	R.T.	---	200	3.5% NaCl	CANT*	---	1	1	---	190	105	---	1972	83613

⁺ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.5.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 18NI(200)(MAR) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	1650F 4.5 HR AC AGED 1000F 6HR	102.3	1.2	3	---	---	---	---	---	---
	1650F 4.5 HR AC AGED 900F 24HR	96.5	0.7	2	---	---	---	---	---	---
	1650F 4.5 HR AC AGED 950F 24HR	99.3	1.2	3	---	---	---	---	---	---
Forging	1650F 4.5 HR AC AGED 900F 6HR	100.3	0.6	3	---	---	---	---	---	---

TABLE 3.5.2.1

ALLOY STEEL 18NI (200) (MAR) K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic}: K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic}: K_{Ic} MEAN	K_{Ic}: STAN DEV	DATE	REFER
1650F 4.5 HR AC AGED 1000F 6 HR	Plate	4.25	R.T.	L-T	211.0	4.700	2.400	CT	2.400	0.60	103.00	102.3	1.2	1972	83834 (1)
		4.25			211.0	7.900	3.900	NB	3.930	0.57	101.00			1972	83834 (1)
		4.25			211.0	6.310	3.900	CT	3.220	0.60	103.00			1972	83834 (1)
1650F 4.5 HR AC AGED 850F 24 HR	Forging	3.00	R.T.	L-T	224.0	6.300	3.900	CT	3.160	0.33	81.00	---	---	1966	76411 (1)
1650F 4.5 HR AC AGED 900F 24 HR	Plate	4.25	R.T.	L-T	219.0	4.730	2.400	CT	2.390	0.48	96.00	96.5	0.7	1972	83834 (1)
		4.25			219.0	7.890	3.900	NB	3.940	0.49	97.00			1972	83834 (1)
1650F 4.5 HR AC AGED 900F 6 HR	Forging	3.00	R.T.	L-T	210.0	6.300	3.900	CT	3.180	0.57	100.00	100.3	0.6	1972	83834 (1)
		3.00			210.0	4.700	2.400	CT	2.360	0.58	101.00			1972	83834 (1)
		3.00			224.0	7.900	3.900	CT	3.880	0.57	100.00			1972	83834 (1)
1650F 4.5 HR AC AGED 950F 24 HR	Plate	4.25	R.T.	L-T	216.0	4.720	2.400	CT	2.390	0.54	100.00	99.3	1.2	1972	83834 (1)
		4.25			216.0	6.300	3.940	CT	3.940	0.54	98.00			1972	83834 (1)
		4.25			216.0	7.870	3.900	NB	3.930	0.54	100.00			1972	83834 (1)

NOTES: (1) VACUUM ARC REMELTED

TABLE 3.5.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(200)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
1500°F 1hr AC; 900°F 3hr	P	R.T.	T-S	219	3.5% NaCl	CANT	---	---	1	---	---	39	20000	1971	80824
						CANT	---	---	1	---	---	94+	60000	1971	81004
1650°F; 900°F 3hr AC	P	R.T.	---	197	3.5% NaCl	CANT*	2.5	0.5	1	---	231	104+	---	1970	84342
1675F 2hr AC; 500°F 15min; 850°F 4hr Cool 250°F/min	P	R.T.	T-S	192.6	3.5% NaCl	CANT*	0.938	0.75	0.94	0.25	146	48	39000	1967	69162
				197.5	3.5% NaCl	CANT*	0.938	0.75	---	0.25	144	78	30000	1967	69162
TYS=215Ksi	P	R.T.	---	215	3.5% NaCl	CANT*	---	1	1	---	125	70	---	1972	83613
Weld center line	P	R.T.	L-S	215	3.5% NaCl	CANT	---	---	---	---	115	70	19000	1967	70887
Unspecified	P	R.T.	L-T	207	Unsymmetrical dimethyl hydrozine	TDCB	53.5	0.5	0.5	---	110	110+	47500	---	80667

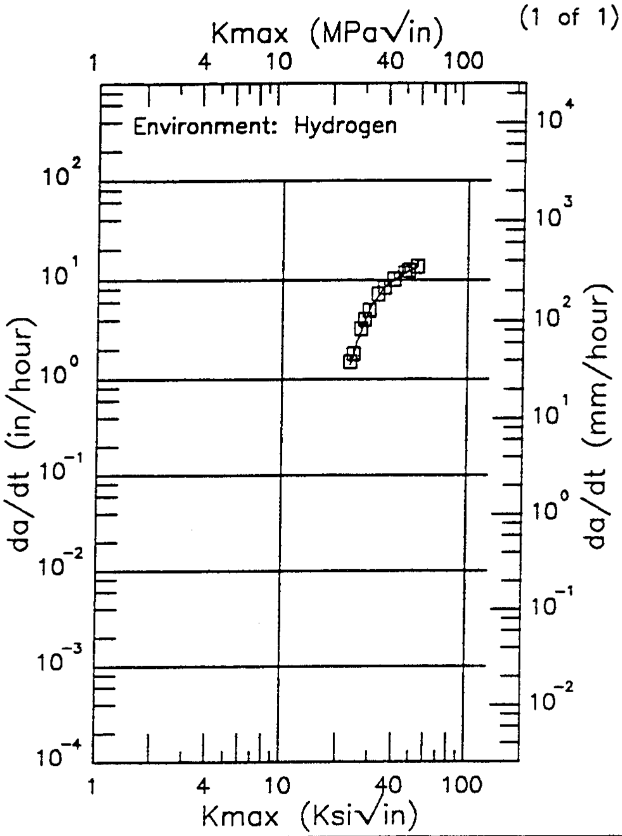
+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

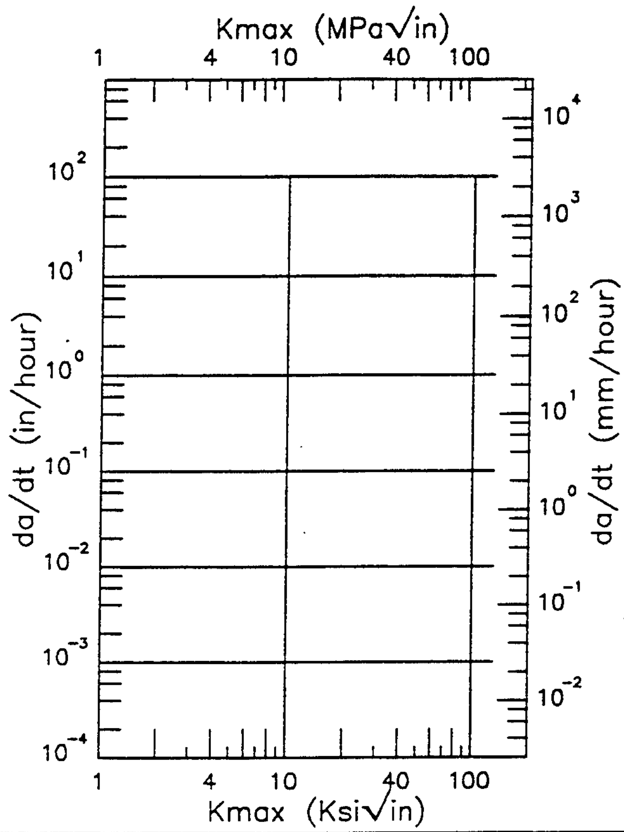
* asterisk in specimen design column indicates that specimens are side-grooved

18NI(250)

Condition/Ht:	
Form:	Specimen Thk:
Specimen Type:	Specimen Width:
Orientation:	A_O:
Yield Strength:	K_{Iscc}:
Ult. Strength:	Ref: 84310

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
23.10 (min)	1403.
25.	2376.
30.	5529.
35.	8306.
40.	10206.
50.	12754.
52.70 (max)	13502.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

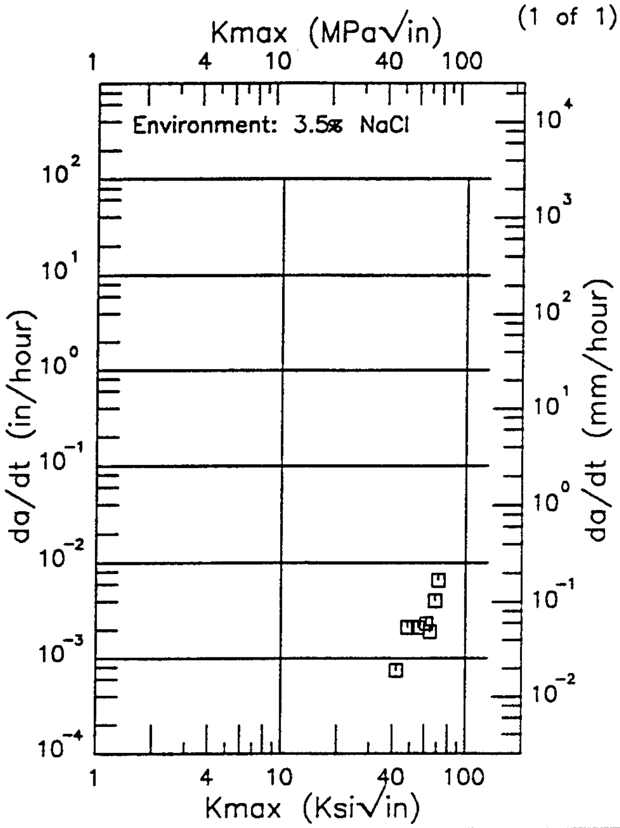
RMS % Error	
3.45	

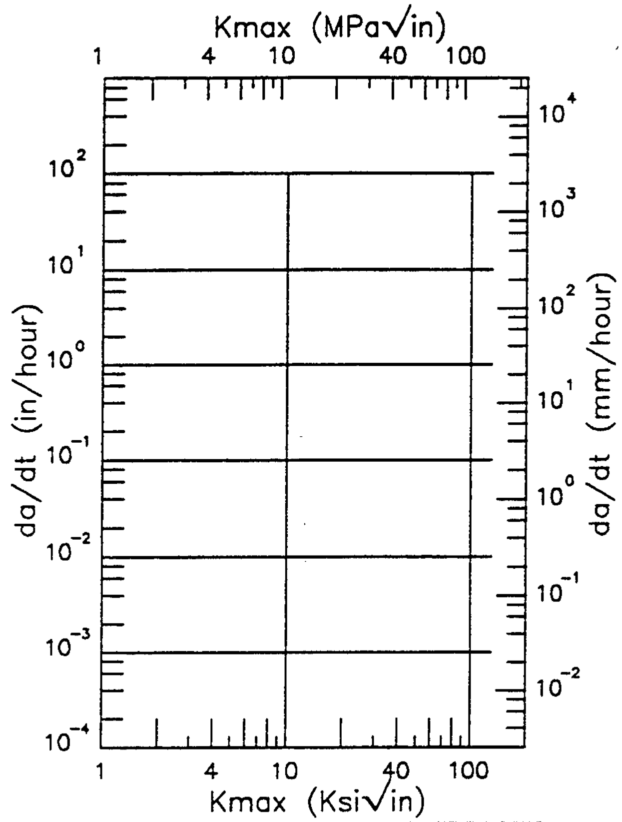
RMS % Error	

Figure 3.6.3.2.1

Condition/Ht:
Form:
Specimen Type: TDCB
Orientation:
Yield Strength:
Ult. Strength:

Specimen Thk:
Specimen Width:
A_o:
K_{Iscc}:
Ref: 78313





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)	Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

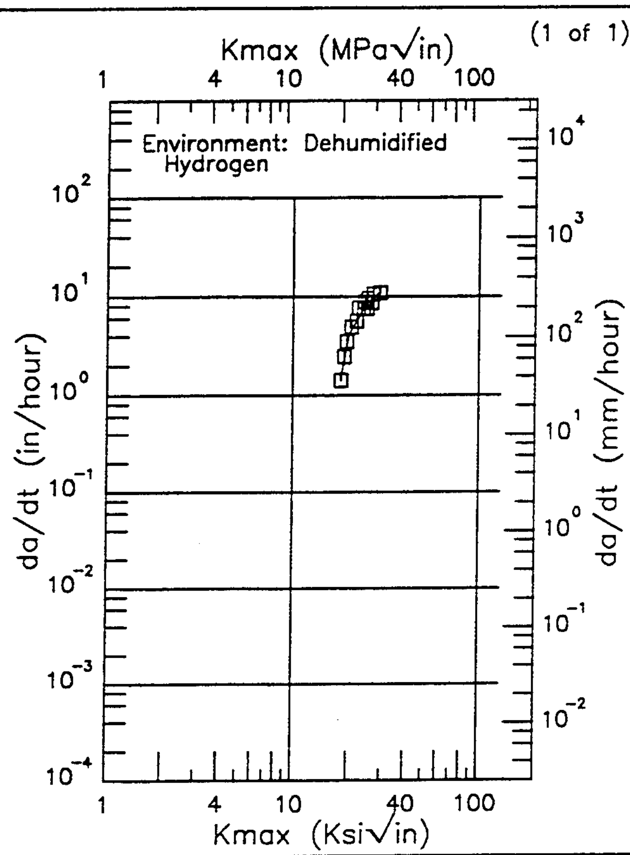
RMS % Error		RMS % Error	

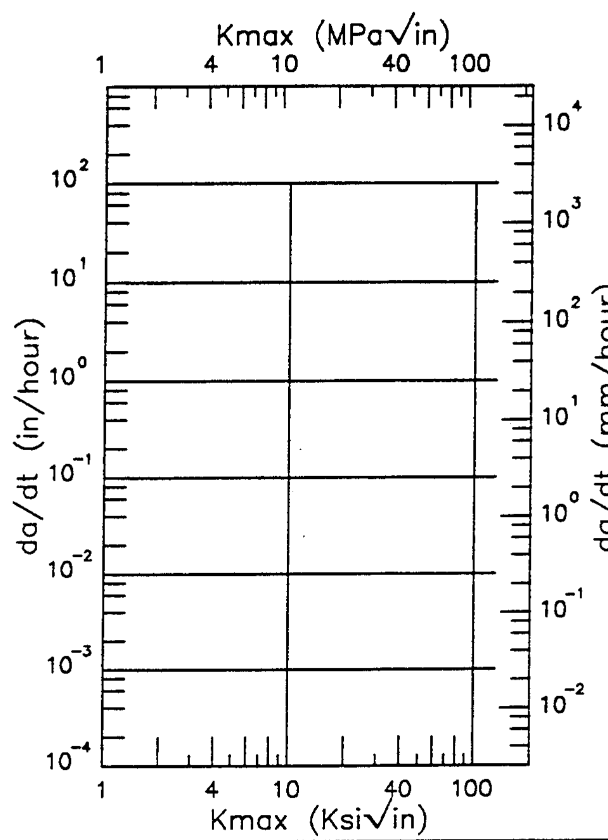
Figure 3.6.3.2.2

18NI(250)

Condition/Ht:	Specimen Thk: 0.25 in.
Form: 0.35 in. Plate	Specimen Width: 2.75 in.
Specimen Type: CNT	Ao:
Orientation:	KIscc:
Yield Strength: 246 ksi	Ref: 70887
Ult. Strength:	

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
18.00 (min)	1494.
20.	4145.
25.	8724.
29.20 (max)	11124.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error 11.21		RMS % Error	

Figure 3.6.3.2.3

TABLE 3.7.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 18NI(250)(MAR) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	1500F AC 850F 6HR	76	1.9	5	---	---	---	---	---	---
	1500F AC 900F 24HR	80.7	1.2	6	---	---	---	---	---	---
	1500F AC 900F 6HR	82.3	3.2	6	---	---	---	---	---	---
	1500F AC 950F 6HR	84	2.6	6	---	---	---	---	---	---
Billet	1500F 1HR AC AGED 900F 3HR AC	74.3	4.2	7	64.1	4.4	6	---	---	---

TABLE 3.7.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 18NI(250)MAR AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=243KSI	BILLET	0.1	1				18.43		

TABLE 3.7.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 18NI(250)MAR AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=243KSI	BILLET	0.1	10			1.16	5.91	71.03	

TABLE 3.7.2.1

ALLOY STEEL 18NI(250)(MAR) K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1500F 1HR AC AGED 900F 3HR AC	Billet	12.00	R.T.	L-T	231.0	2.000	1.020	NB	---	0.24	70.90	74.3	4.2	1974	90981 (1)
		12.00			231.0	2.000	1.020	NB	---	0.26	74.90			1974	90981 (1)
		1.00			233.0	2.000	1.020	NB	---	0.24	72.20			1974	90981 (1)
		12.00			233.0	1.000	0.500	CT	---	0.25	73.40			1974	90981 (1)
		12.00			233.0	1.000	0.500	CT	---	0.27	77.20			1974	90981 (1)
		12.00			233.0	2.000	1.020	NB	---	0.22	69.60			1974	90981 (1)
		12.00			233.0	1.000	0.500	CT	---	0.31	81.80			1974	90981 (1)
1500F 1HR AC AGED 900F 3 HR AC	Billet	12.00	R.T.	T-L	232.0	2.000	1.020	NB	---	0.22	69.10	64.1	4.4	1974	90981 (1)
		12.00			232.0	2.000	1.020	NB	---	0.17	61.00			1974	90981 (1)
		12.00			232.0	1.000	0.500	CT	---	0.20	65.00			1974	90981 (1)
		12.00			232.0	1.000	0.500	CT	---	0.22	69.20			1974	90981 (1)
		12.00			232.0	2.000	1.020	NB	---	0.16	59.00			1974	90981 (1)
		12.00			232.0	1.000	0.500	CT	---	0.17	61.20			1974	90981 (1)
1500F AC 850F 6HR	Plate	4.25	R.T.	L-T	253.0	3.750	1.800	NB	1.800	0.22	73.00	76.0	1.9	1972	83834
		4.25			253.0	3.000	1.800	CT	1.800	0.24	78.00			1972	83834
		4.25			253.0	3.000	1.800	CT	1.800	0.23	77.00			1972	83834
		4.25			253.0	3.750	1.800	NB	1.800	0.22	76.00			1972	83834
		4.25			253.0	3.000	1.800	CT	1.800	0.22	76.00			1972	83834

NOTES: (1) COMPOSITION (WT PERCENT) 0.014C, 0.087Mn, 0.006P, 0.07Si, 18.6Ni, 0.10Cr, 4.75Mo, 0.41Ti, 0.11Al

TABLE 3.7.2.1 (CONCLUDED)

ALLOY STEEL 18NI(250)(MAR) K_{Ic}

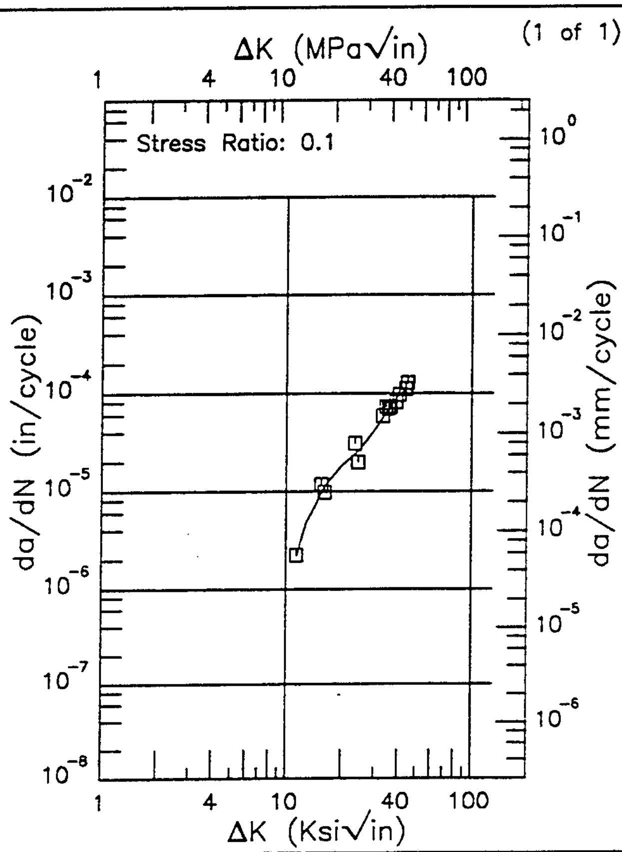
CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1500F AC 900F 24HR	Plate	2.00	R.T.	L-T	259.0	3.000	1.800	CT	1.800	0.25	82.00	80.7	1.2	1968	73612
		2.00			259.0	3.750	1.800	NB	1.800	0.24	80.00			1968	73612
		2.00			259.0	3.750	1.800	NB	1.800	0.25	82.00			1968	73612
		2.00			259.0	3.000	1.800	CT	1.800	0.24	81.00			1968	73612
		2.00			259.0	3.000	1.800	CT	1.800	0.24	80.00			1968	73612
		2.00			259.0	3.750	1.800	NB	1.800	0.23	79.00			1968	73612
1500F AC 900F 6HR	Plate	2.00	R.T.	L-T	259.0	3.000	1.800	CT	1.800	0.23	79.00	82.3	3.2	1968	73612
		2.00			259.0	3.750	1.800	NB	1.800	0.24	81.00			1968	73612
		2.00			259.0	3.750	1.800	NB	1.800	0.26	84.00			1968	73612
		2.00			259.0	3.000	1.800	CT	1.800	0.24	81.00			1968	73612
		2.00			259.0	3.000	1.800	CT	1.800	0.24	81.00			1968	73612
		2.00			259.0	3.750	1.800	NB	1.800	0.29	88.00			1968	73612
1500F AC 950F 6HR	Plate	2.00	R.T.	L-T	252.0	3.000	1.800	CT	1.800	0.28	84.00	84.0	2.6	1968	73612
		2.00			252.0	3.750	1.800	NB	1.800	0.26	82.00			1968	73612
		2.00			252.0	3.750	1.800	NB	1.800	0.28	84.00			1968	73612
		2.00			252.0	3.000	1.800	CT	1.800	0.27	83.00			1968	73612
		2.00			252.0	3.000	1.800	CT	1.800	0.26	82.00			1968	73612
		2.00			252.0	3.750	1.800	NB	1.800	0.32	89.00			1968	73612

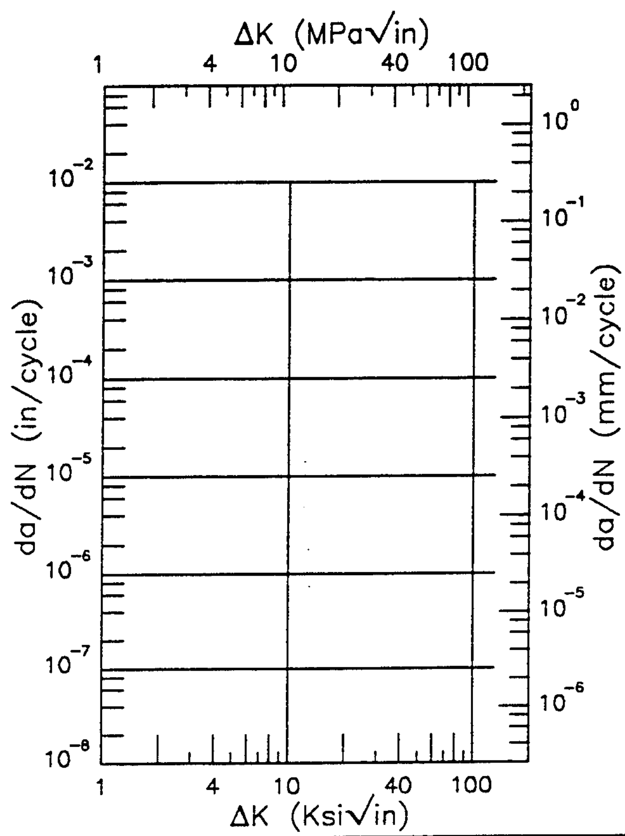
18NI(250)MAR

R

Condition/Ht: UTS=243KSI
Form: 12 in. Billet
Specimen Type: CT
Orientation: L–T
Frequency: 1 Hz
Environment: 3.5% NACL; RT

Yield Strength: 232.7 ksi
Ult. Strength: 243.5 ksi
Specimen Thk: 1.001 in.
Specimen Width: 2.554 in.
Ref: 90981





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.39 (min)	2.23
13.	4.96
16.	11.2
20.	18.4
25.	27.3
30.	42.2
35.	66.9
40.	94.6
45.03 (max)	113.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
13.38

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

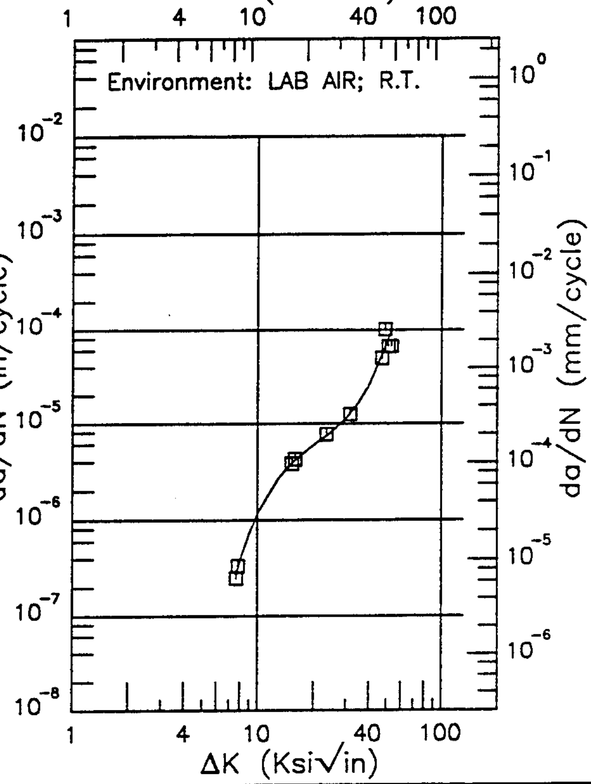
0. .5 .8 1.25 2.

Figure 3.7.3.1.1

Condition/Ht: UTS=243KSI
Form: 12 in. Billet
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.1
Frequency: 10 Hz

Yield Strength: 231.8 ksi
Ult. Strength: 243 ksi
Specimen Thk: 1 - 1.001 in.
Specimen Width: 2.553 in.
Ref: 90981

(1 of 2)

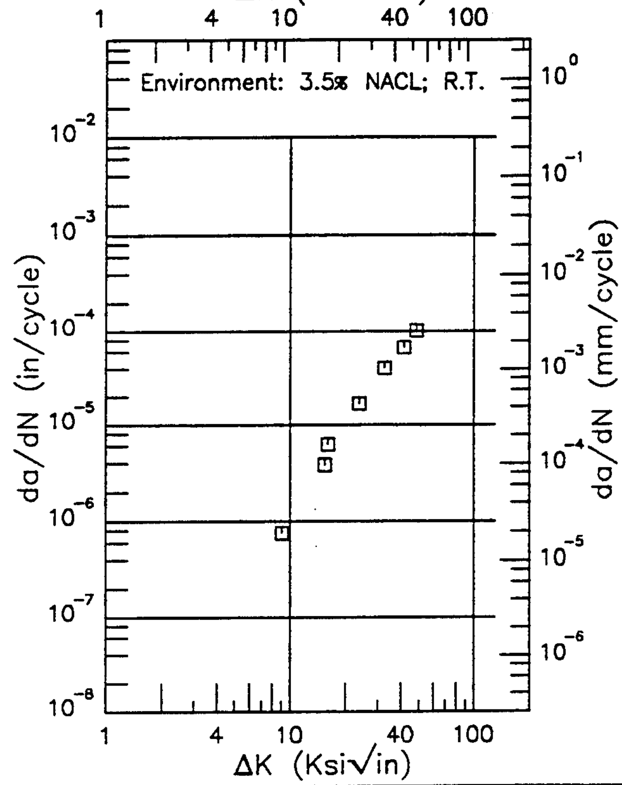


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.69 (min)	0.291
8.	0.373
9.	0.716
10.	1.16
13.	2.73
16.	4.21
20.	5.91
25.	8.16
30.	11.4
35.	16.7
40.	25.7
50.	71.0
52.78 (max)	97.0

RMS % Error: 20.85

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 3.7.3.1.2

TABLE 3.7.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(250)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
Unspecified	P	R.T.	---	252	Synth. Seawater	CANT*	1	1	1	---	72.6	49	30000	1966	65166
				259	Synth. Seawater	CANT*	3	1	1.25	1.05	93	35	60000	1968	73829
						CANT*	0.5	1	1.25	0.17	68	21	60000	1968	73829
						CANT*	1	1	1.25	0.35	78	37	60000	1968	73829
						CANT*	5	1	1.25	1.75	95	38	60000	1968	73829
						---	---	---	---	---	---	36.5	---	1969	74232
1650F 1.25hr WQ; 1525F 1.25hr WQ; 900F 3hr AC	P	R.T.	---	259	Synth. Seawater	CANT*	3	1	1.25	---	93	35	---	1970	78065
						CANT*	1	1	1.25	---	78	37	---	1970	78065
						CANT*	5	1	1.25	---	95	38	---	1970	78065
900F 2hr AC	S	R.T.	---	228	3.5% NaCl	CNT	2	0.05	0.08	---	---	110+	20000	1968	72283
					Dist. Water	CNT	2	0.05	0.08	---	---	110+	30000	1968	72283
Age 900F 3hr	P	R.T.	L-T	249	3.5% NaCl	NB	1.5	0.48	0.48	---	92	45	---	1971	84351
Aged 900F 3hr AC	P	R.T.	L-S	---	3.5% NaCl	CANT*	0.5	0.375	0.5	---	---	50	---	1971	80824
						CANT	0.482	0.375	0.5	---	---	31	---	1971	80824
TYS=250Ksi	P	R.T.	---	250	3.5% NaCl	CANT*	---	1	1	---	70	50	---	1972	83613
TYS=260Ksi	P	R.T.	---	260	3.5% NaCl	CANT*	---	1	1	---	95	70	---	1972	83613

+ specimen thickness does not meet minimum requirements of $2.5 \left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.8.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(280)(MAR)

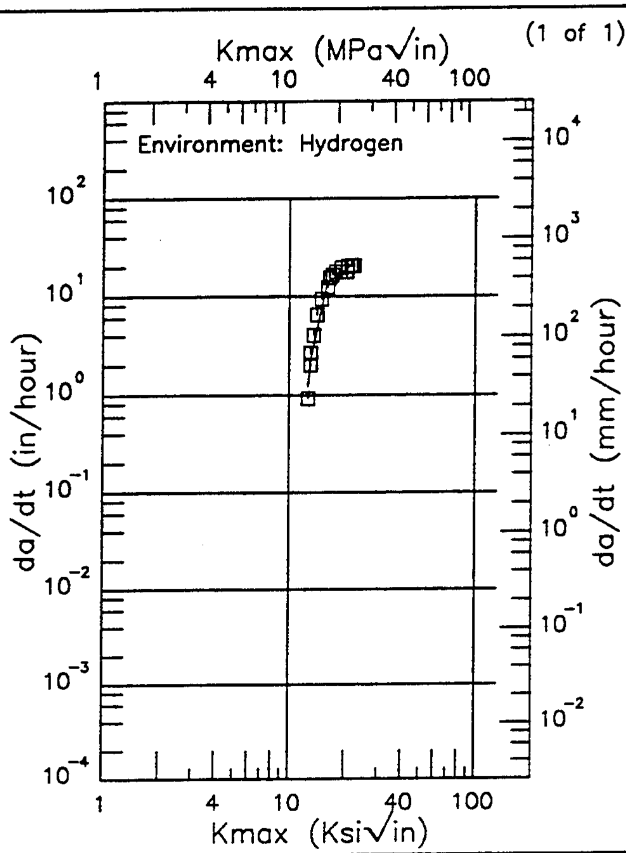
Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1500°F 1hr AC; 900°F 3hr	P	R.T.	---	277	3.5% NaCl	CANT	0.75	0.75	---	---	60	14	14400	1971	82164

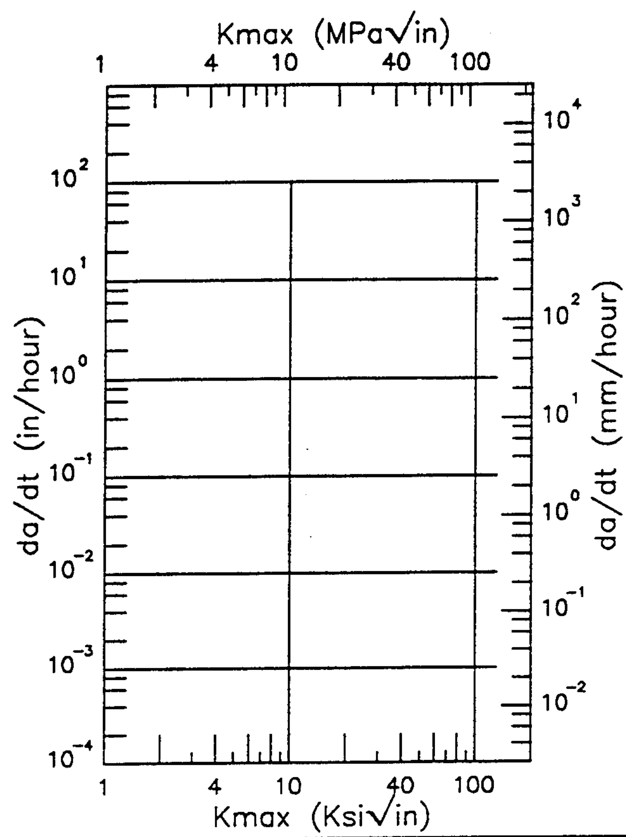
18NI(300)

Condition/Ht:
Form:
Specimen Type:
Orientation:
Yield Strength:
Ult. Strength:

Specimen Thk:
Specimen Width:
A_0:
K_{Iscc}:
Ref: 84310

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
12.60 (min)	1246.
13.	2157.
16.	14144.
20.	18378.
22.20 (max)	22032.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error	
20.61	

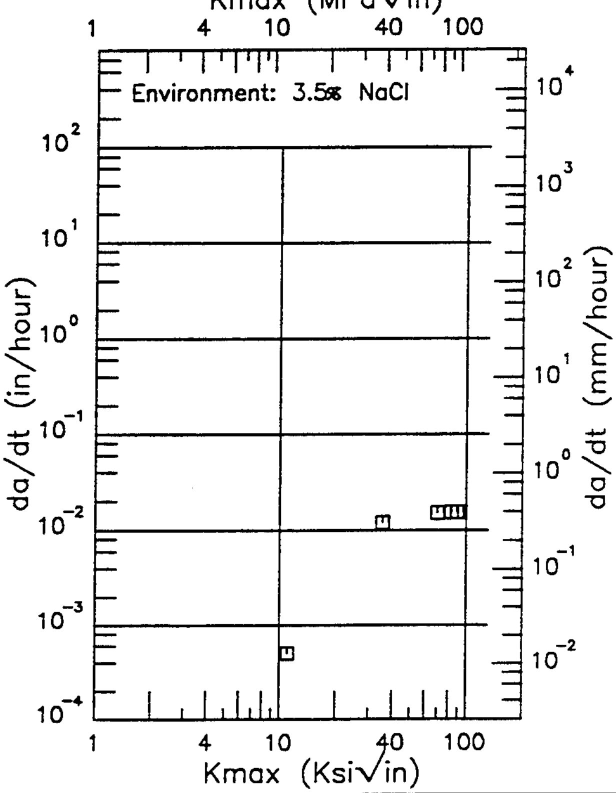
RMS % Error	

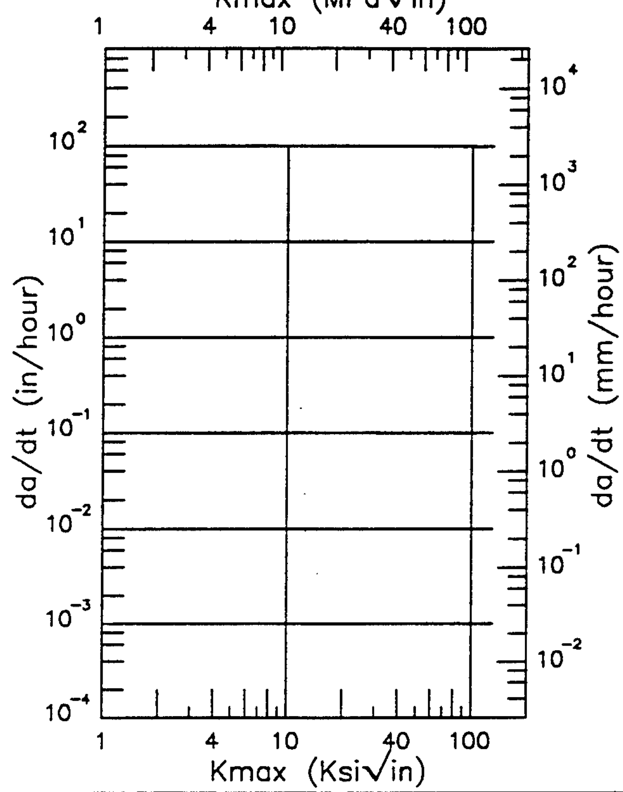
Figure 3.9.3.2.1

Condition/Ht: AGED 6HR 900F
Form:
Specimen Type: NB – 3 pt
Orientation:
Yield Strength:
Ult. Strength:

Specimen Thk: 0.5 in.
Specimen Width: 1.5 in.
A_O:
K_{Iscc}:
Ref: 74719

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)	Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error		RMS % Error	

Figure 3.9.3.2.2

TABLE 3.10.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 18NI(300)MAR AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.67	2				10.18		

TABLE 3.10.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 18NI(300)MAR AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.06	2					23.22	
		0.67	2			1.51	9.38		

TABLE 3.10.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 18NI(300)MAR AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.67	2			1.49	7.42		

TABLE 3.10.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 18NI(300)MAR AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: Dry Argon**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) *ΔK Level (Ksi√in)* 2.5	5.0	10.0	20.0	50.0	100.0
AGED	UNSPECIFIED	0.05	20			0.17	1.98		
ANNEALED	UNSPECIFIED	0.05	20			0.18	2.1		

TABLE 3.10.2.1

ALLOY STEEL 18NI(300)(MAR) K_{Ic}															
CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi • $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1700F 1HR AC 1500F 1HR AC 900F 6HR	Forging	10.00	-65	L-R	---	1.000	0.500	NB	0.500	---	54.00	---	---	1970	78425
1700F 1HR AC 1500F 1HR AC 900F 6HR	Forging	10.00	R.T.	L-R	280.0	1.000	0.500	NB	0.500	0.16	71.20	67.7	4.9	1970	78425
		10.00			300.0	1.000	0.500	NB	0.500	0.11	64.20			1970	78425
1700F 1HR AC 1500F 1HR AC 900F 6HR	Forging	10.00	R.T.	R-C	280.0	1.000	0.500	NB	0.500	0.18	75.50	69.0	9.2	1970	78425
		10.00			299.0	1.000	0.500	NB	0.500	0.11	62.50			1970	78425
900F AGED	Plate	1.00	R.T.	L-T	276.0	0.800	0.400	CT	0.400	---	---	---	---	1971	86582 (1)

NOTES: (1) COMPOSITION (WT PERCENT) 0.017C, 0.05Mn, 0.004P, 0.007S, 0.09Si, 18.8Ni, 4.95Mo, 7.2Cb, 0.58Ti, 0.13Al

TABLE 3.10.2.2

18NI(300)MAR K_C

CONDITION HEAT TREAT	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	CRACK LENGTH INIT (in.) $2a_o$	CRACK LENGTH FINAL (in.) $2a_f$	GROSS STRESS ONSET (Ksi) σ_o	GROSS STRESS MAX (Ksi) σ_{Max}	K_{app} (Ksi$\sqrt{in.}$)	K_{app} MEAN	K_{app} STAN DEV	K_C (Ksi$\sqrt{in.}$)	K_C MEAN	K_C STAN DEV	DATE	REFER
BUCKLING OF CRACK EDGES NOT RESTRAINED																			
		0.03			386.0	4.000	0.026	1.250	1.290	---	63.80	95.20			97.12			1964	60578
		0.03			386.0	4.010	0.028	1.230	1.230	---	55.80	82.39			82.39			1964	60578
---	Sheet	0.03	-423	L-T	386.0	4.020	0.028	1.170	1.170	---	55.80	79.86	84.8	6.0	79.86	86.4	7.3	1964	60578
		0.03			386.0	4.010	0.029	1.250	1.400	---	56.50	84.28			90.70			1964	60578
		0.03			386.0	4.010	0.029	1.250	1.250	---	55.00	82.04			82.04			1964	60578
		0.03			336.0	2.020	0.025	0.590	0.590	---	150.00	152.50			152.50			1964	60578
		0.03			336.0	2.020	0.025	0.590	0.590	---	141.00	143.35			143.35			1964	60578
---	Sheet	0.03	-320	L-T	336.0	2.020	0.025	0.590	0.590	---	141.00	143.35	142.6	7.4	143.35	142.6	7.4	1964	60578
		0.03			336.0	2.020	0.025	0.580	0.580	---	131.00	131.80			131.80			1964	60578
		0.03			336.0	2.020	0.025	0.600	0.600	---	138.00	141.76			141.76			1964	60578
		0.03			336.0	3.950	0.026	1.230	1.230	---	76.50	113.18			113.18			1964	60578
		0.03			336.0	4.020	0.026	1.240	1.240	---	88.00	130.56			130.56			1964	60578
---	Sheet	0.03	-320	L-T	336.0	4.010	0.027	1.240	1.250	---	89.50	132.83	124.1	7.9	133.50	124.2	8.0	1964	60578
		0.03			336.0	4.020	0.027	1.240	1.240	---	81.90	121.51			121.51			1964	60578
		0.03			336.0	4.020	0.027	1.240	1.240	---	82.50	122.40			122.40			1964	60578

TABLE 3.10.2.2 (CONCLUDED)

18NI(300)MAR K_C																			
CONDITION HEAT TREAT	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN		CRACK LENGTH		GROSS STRESS		K_{app}			K_C			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	INIT (in.) $2a_o$	FINAL (in.) $2a_f$	ONSET (Ksi) σ_o	MAX (Ksi) σ_{Max}	K_{app} (Ksi√in.)	K_{app} MEAN	STAN DEV	K_c (Ksi√in.)	K_c MEAN	STAN DEV		
BUCKLING OF CRACK EDGES NOT RESTRAINED																			
---	Sheet	0.03	R.T.	L-T	277.0	2.020	0.025	0.580	0.580	---	133.00	133.81	131.6	3.5	133.81	132.1	4.3	1964	60578
		0.03			277.0	2.020	0.025	0.580	0.580	---	130.00	130.80			130.80			1964	60578
		0.03			277.0	2.020	0.025	0.550	0.550	---	136.00	132.52			132.52			1964	60578
		0.03			277.0	2.010	0.026	0.580	0.580	---	125.00	125.83			125.83			1964	60578
		0.03			277.0	2.020	0.026	0.580	0.600	---	134.00	134.82			137.65			1964	60578
---	Sheet	0.03	R.T.	L-T	277.0	4.000	0.028	1.240	1.240	---	83.80	124.41	128.1	4.1	124.41	128.5	3.8	1964	60578
		0.03			277.0	4.000	0.028	1.240	1.240	---	89.20	132.42			132.42			1964	60578
		0.03			277.0	4.000	0.028	1.240	1.240	---	87.40	129.75			129.75			1964	60578
		0.03			277.0	4.000	0.028	1.240	1.260	---	83.00	123.22			124.47			1964	60578
		0.03			277.0	4.000	0.029	1.230	1.240	---	88.50	130.72			131.39			1964	60578
---	Sheet	0.03	R.T.	L-T	277.0	17.700	0.025	5.490	5.490	---	34.70	108.40	---	---	108.40	---	---	1964	60578
---	Sheet	0.03	R.T.	L-T	277.0	18.100	0.022	5.470	5.470	---	33.70	104.74	110.3	11.0	104.74	110.3	10.9	1964	60578
		0.03			277.0	18.060	0.025	5.490	5.500	---	33.10	103.14			103.26			1964	60578
		0.03			277.0	18.100	0.025	5.480	5.480	---	39.50	122.91			122.91			1964	60578

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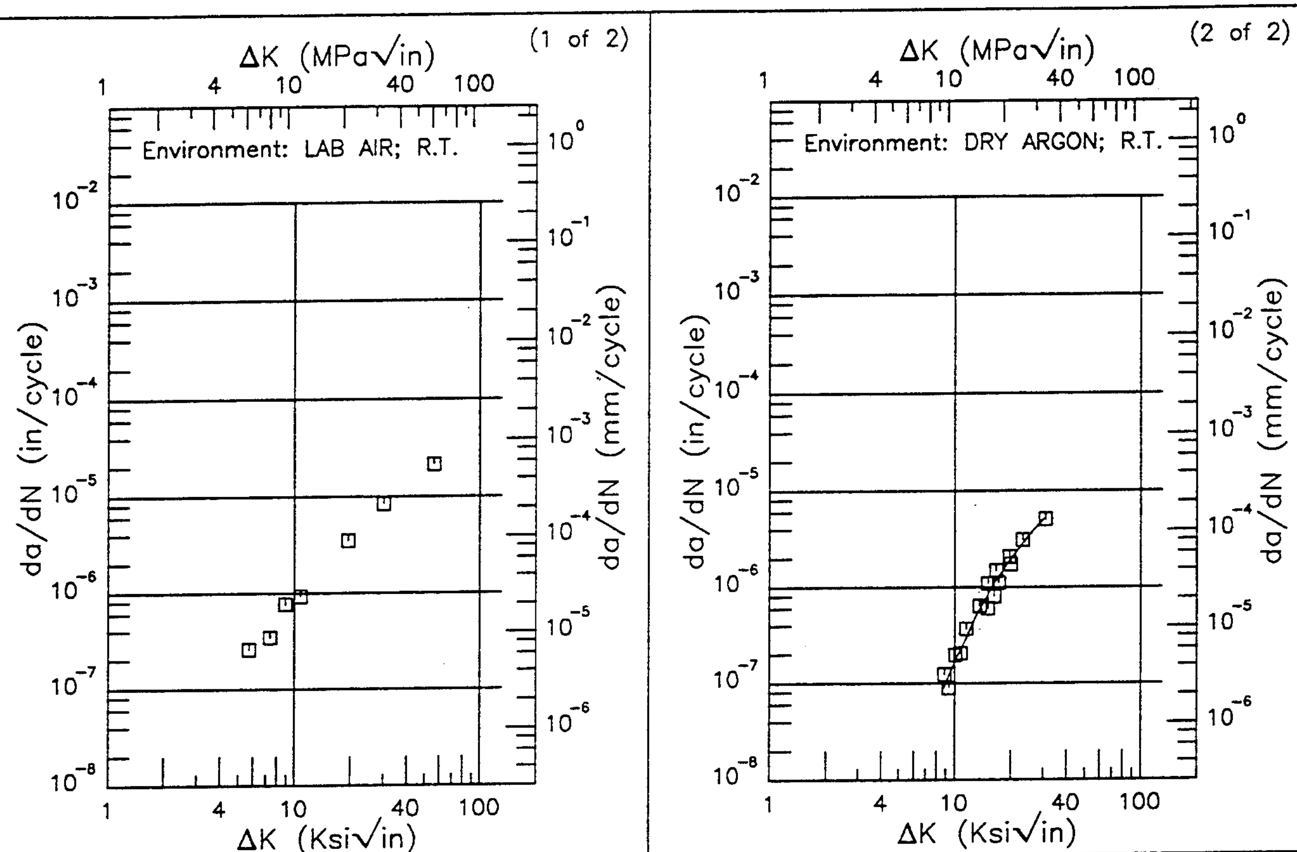
18NI(300)MAR

E

Condition/Ht: AGED	
Form:	Yield Strength:
Specimen Type:	Ult. Strength:
Orientation:	Specimen Thk:
Stress Ratio: 0.05	Specimen Width:
Frequency: 20 Hz	Ref: 91838



(1 of 2)

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

(2 of 2)

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.77 (min)	0.0905
9.	0.103
10.	0.169
13.	0.500
16.	1.03
20.	1.98
25.	3.42
30.	4.99
30.62 (max)	5.19

(1 of 2)

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)

RMS % Error

20.59

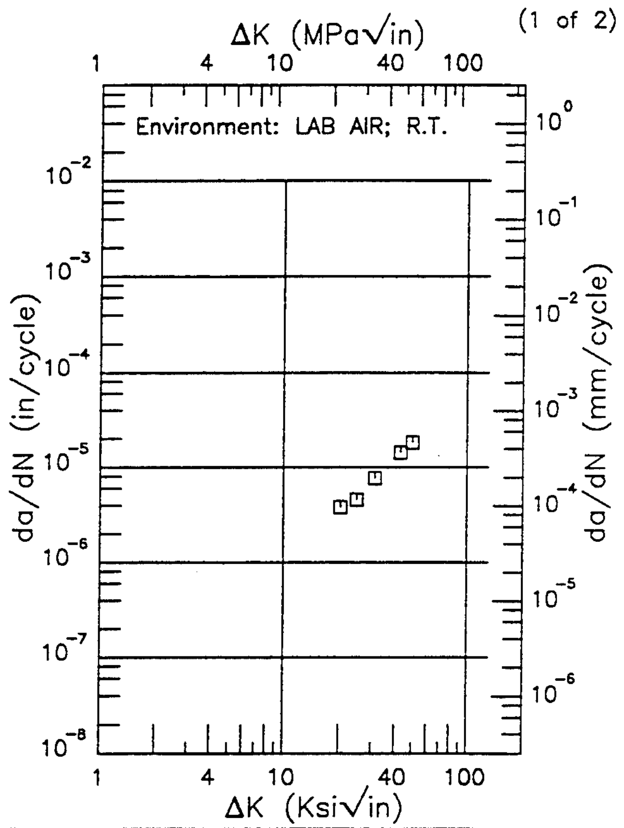
Life Prediction Ratio Summary

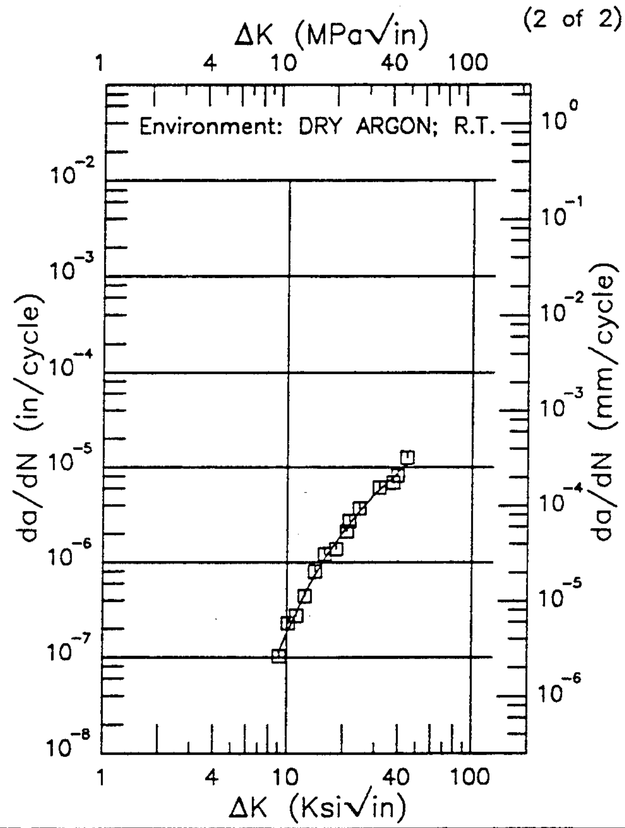
0. .5 .8 1.25 2.

Figure 3.10.3.1.1

Condition/Ht: ANNEALED
Form:
Specimen Type:
Orientation:
Stress Ratio: 0.05
Frequency: 20 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 91838





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.05 (min)	0.112
10.	0.183
13.	0.546
16.	1.11
20.	2.10
25.	3.57
30.	5.22
35.	7.00
40.	8.93
44.46 (max)	10.8

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
11.02	0. .5 .8 1.25 2.

Figure 3.10.3.1.2

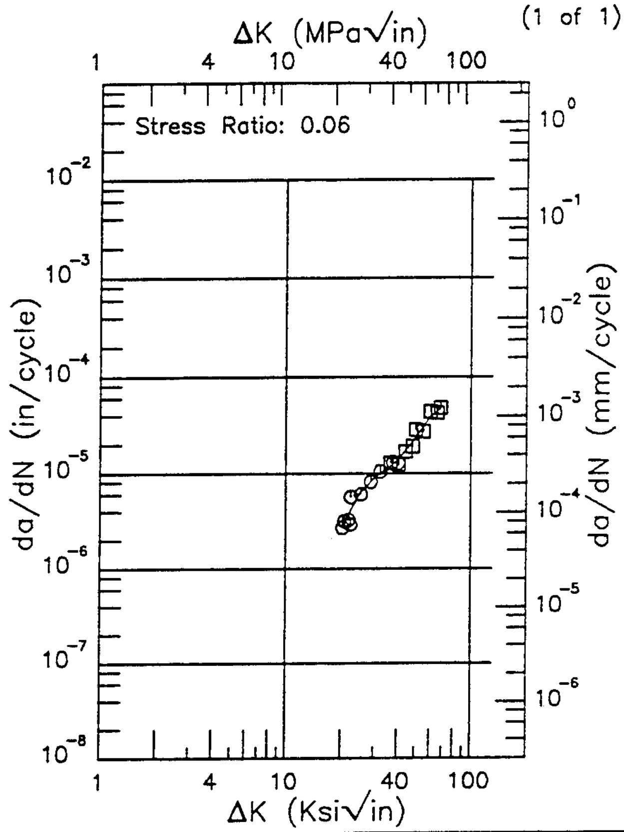
R

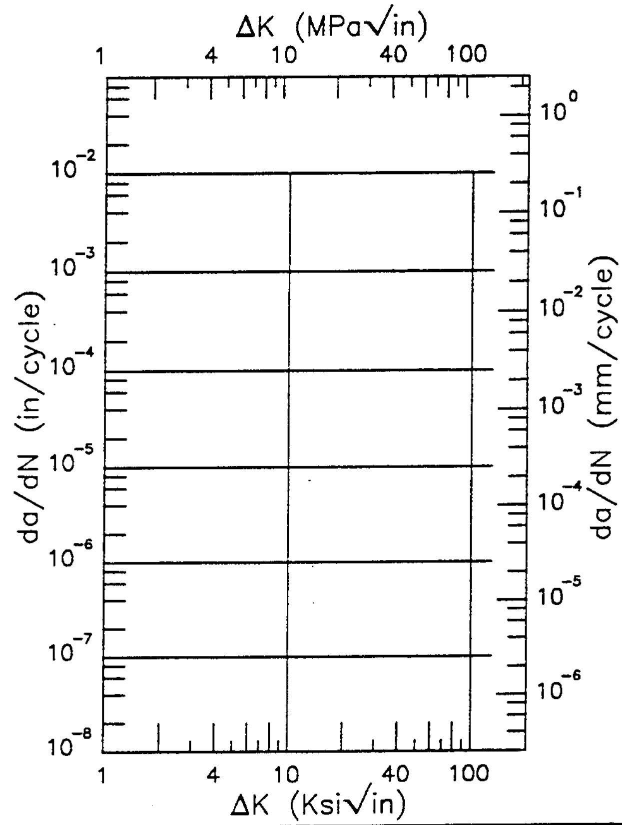
18NI(300)MAR

Condition/Ht:
Form: 0.13 in. Forging
Specimen Type: CCP (max stress specified)
Orientation: L−T
Frequency: 2 Hz
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.125 in.
Specimen Width: 3 in.
Ref: 78425

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
20.16 (min)	2.74
25.	6.18
30.	8.91
35.	11.1
40.	13.5
50.	23.2
60.	38.1
67.79 (max)	46.5

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
13.67	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.10.3.1.3

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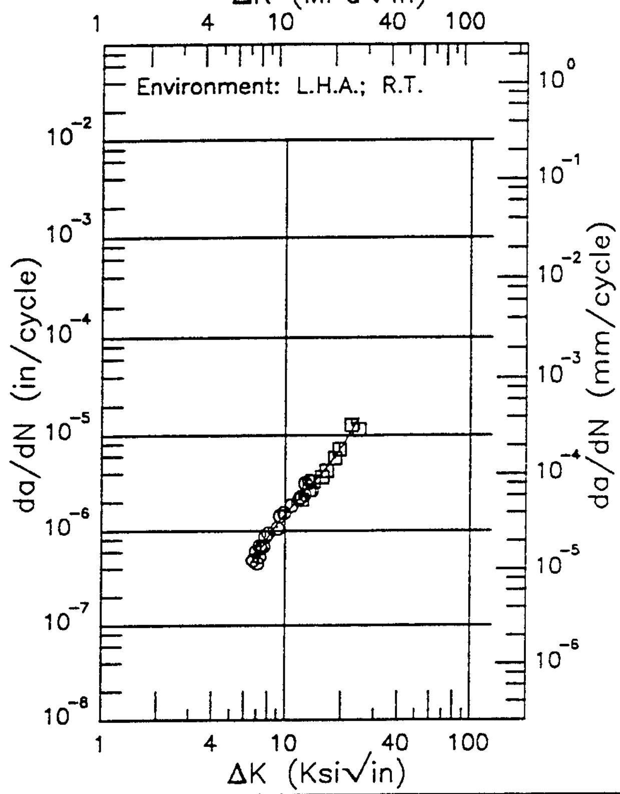
18NI(300)MAR

E

Condition/Ht:
Form: 0.13 in. Forging
Specimen Type: CCP (max stress specified)
Orientation: L–T
Stress Ratio: 0.67
Frequency: 2 Hz

Yield Strength:
Ult. Strength:
Specimen Thk: 0.125 in.
Specimen Width: 3 in.
Ref: 78425

(1 of 3)



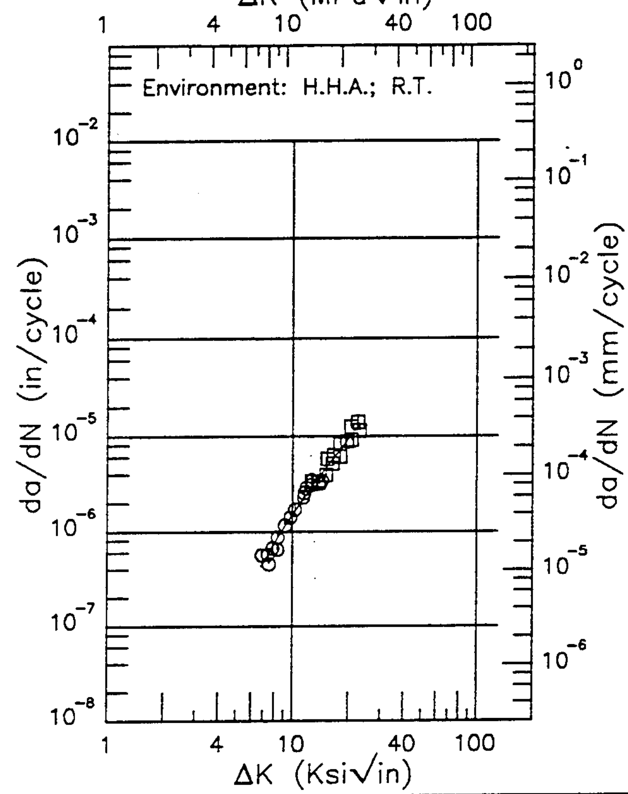
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.67 (min)	0.474
7.	0.561
8.	0.847
9.	1.16
10.	1.49
13.	2.63
16.	4.15
20.	7.42
24.71 (max)	15.1

RMS % Error: 11.20

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.85 (min)	0.435
7.	0.472
8.	0.753
9.	1.10
10.	1.51
13.	3.11
16.	5.30
20.	9.38
22.98 (max)	13.6

RMS % Error: 14.36

Life Prediction Ratio Summary

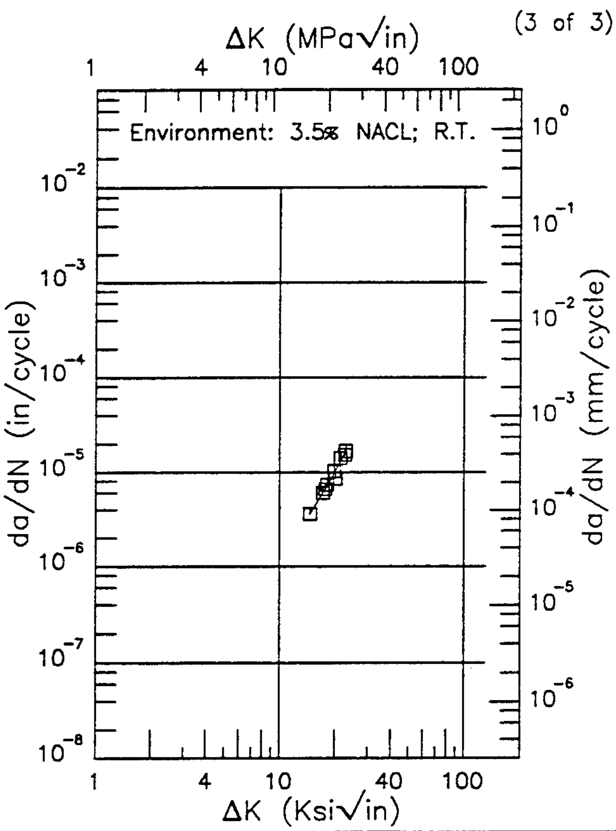
0. .5 .8 1.25 2.

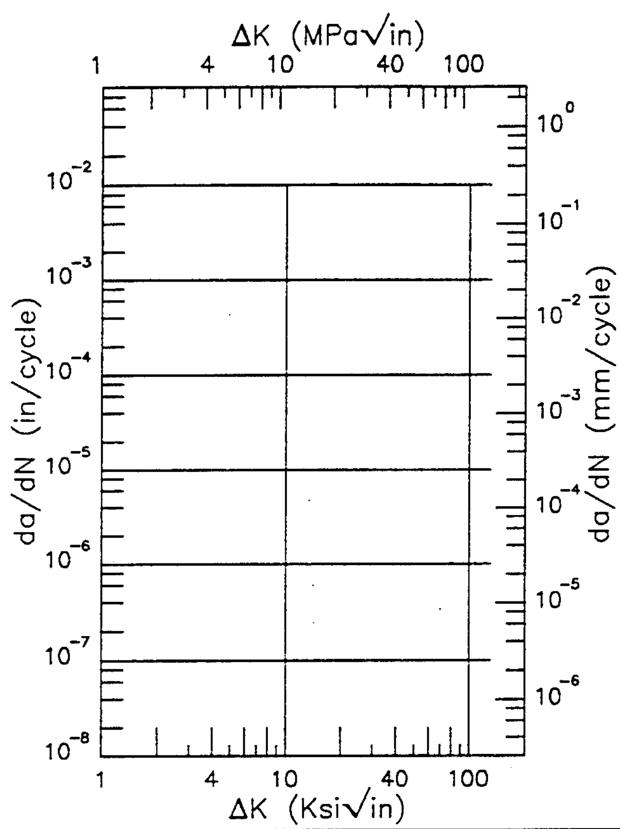
Figure 3.10.3.1.4

Condition/Ht:
Form: 0.13 in. Forging
Specimen Type: CCP (max stress specified)
Orientation: L–T
Stress Ratio: 0.67
Frequency: 2 Hz

Yield Strength:
Ult. Strength:
Specimen Thk: 0.125 in.
Specimen Width: 3 in.
Ref: 78425

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.61 (min)	3.56
16.	4.82
20.	10.2
22.60 (max)	16.4

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
6.81

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

Figure 3.10.3.1.4 (Concluded)

TABLE 3.10.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(300)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1500°F 0.5hr; AC 900°F 3hr	P	R.T.	L-S	285.8	Dist. Water	CANT*	1	0.25	0.25	0.2	93.9	36	10000	1965	63061
						CANT*	1	0.25	0.25	0.2	63.1	60	10000	1965	63061
1500°F 2hr 800°F 10hr	B	R.T.	L-S	280	1N H_2SO_4	CANT*	0.625	0.5	---	---	120	10	---	1970	77716
					3% NaCl Ph1.7	CANT*	0.625	0.5	---	---	120	9	10000	1970	77716
					3% NaCl Ph6.3	CANT*	0.625	0.5	---	---	120	10	---	1970	77716
					Dist. Water	CANT*	0.625	0.5	---	---	120	9	---	1970	77716
1500°F 2hr 900°F 3.5hr	B	R.T.	L-S	280	1.5% Na_2Cr_2O7	CANT*	0.625	0.5	---	---	99	12	---	1970	77716
1500°F 2hr 900°F 100hr	B	R.T.	L-S	280	1N H_2SO_4	CANT*	0.625	0.5	---	---	70	9	---	1970	77716
					3% NaCl -0.4V to -1.2V	CANT*	0.625	0.5	---	---	70	9	---	1970	77716
					3% NaCl O_2 Sat.	CANT*	0.625	0.5	---	---	70	10	---	1970	77716
1500°F 2hr 900°F 3.5hr	B	R.T.	L-S	280	3% NaCl Ph1.7	CANT*	0.625	0.5	---	---	99	10	10000	1970	77716
1500°F 2hr 900°F 100hr	B	R.T.	L-S	280	3% NaCl Ph1.7	CANT*	0.625	0.5	---	---	70	15	10000	1970	77716

TABLE 3.10.3.3 (CONTINUED)

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(300)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1500°F 2hr 900°F 3.5hr	B	R.T.	L-S	280	3% NaCl Ph11	CANT*	0.625	0.5	---	---	99	12	---	1970	77716
					3% NaCl Ph3.9	CANT*	0.625	0.5	---	---	99	17	---	1970	77716
					3% NaCl Ph6.3	CANT*	0.625	0.5	---	---	99	8	---	1970	77716
1500°F 2hr 900°F 100hr	B	R.T.	L-S	280	3% NaCl Ph6.3	CANT*	0.625	0.5	---	---	70	10	---	1970	77716
1700°F 1500°F Aged 900°F 6hr	F	R.T.	T-L	284	3.5% NaCl	CHAR	1	0.4	9	---	72.4	7.5	---	1970	78761
2300°F 1hr 1700°F 4hr 900°F 100hr	B	R.T.	L-S	280	1N H_2SO_4	CANT*	0.625	0.5	---	---	53	10	---	1970	77716
					3% NaCl Ph1.7	CANT*	0.625	0.5	---	---	53	10	---	1970	77716
2300°F 1hr 1700°F 4hr 800°F 10hr	B	R.T.	L-S	280	3% NaCl Ph1.7	CANT*	0.625	0.5	---	---	58	14	---	1970	77716
2300°F 1hr 1700°F 4hr 900°F 3.5hr	B	R.T.	L-S	280	3% NaCl Ph1.7	CANT*	0.625	0.5	---	---	57	8	---	1970	77716
2300°F 1hr 1700°F 4hr 800°F 10hr	B	R.T.	L-S	280	3% NaCl Ph6.3	CANT*	0.625	0.5	---	---	58	13	---	1970	77716

TABLE 3.10.3.3 (CONCLUDED)

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(300)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
2300°F 1hr 1700°F 4hr 900°F 3.5hr	B	R.T.	L-S	280	3% NaCl Ph6.3	CANT*	0.625	0.5	---	---	57	9	---	1970	77716
2300°F 1hr 1700°F 4hr 900°F 100hr	B	R.T.	L-S	280	3% NaCl Ph6.3	CANT*	0.625	0.5	---	---	53	9	---	1970	77716
900°F 3hr 950°F 3hr	F	R.T.	T-L	306	3.5% NaCl	CANT	1.5	0.48	1	---	70	5	---	1970	78425
Age 900°F 6hr	F	R.T.	L-T	302	3.5% NaCl	CANT	1.5	0.48	1	---	70	7	---	1970	78425
			T-L	284.3	3.5% NaCl	CANT	1	0.5	9	---	72.4	5	---	1972	84356
				302	3.5% NaCl	CANT	1.5	0.48	1	---	70	7	---	1970	78425
Age 950°F 12hr	F	R.T.	T-L	302	3.5% NaCl	CANT	1.5	0.48	1	---	68	6	---	1970	78425
Crack Prestressed to 50% K_{Ic}	F	R.T.	T-L	284.3	3.5% NaCl	CANT	1	0.5	9	---	72.4	5	---	1972	84356
Crack Prestressed to 80% K_{Ic}	F	R.T.	T-L	284.3	3.5% NaCl	CANT	1	0.5	9	---	72.4	10	---	1972	84356
Crack Prestressed to 25% K_{Ic}	F	R.T.	T-L	284.3	3.5% NaCl	CANT	1	0.5	9	---	72.4	5	---	1972	84356

* asterisk in specimen design column indicates that specimens are side-grooved

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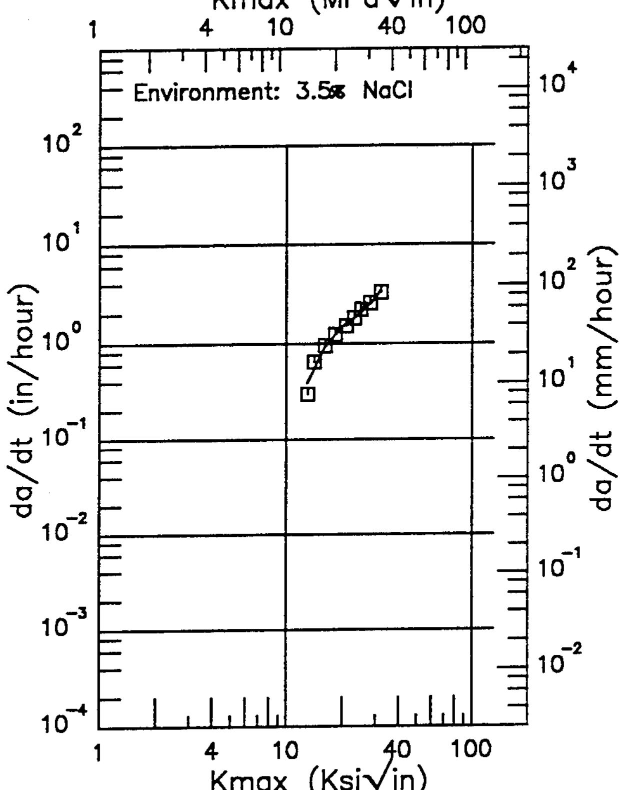
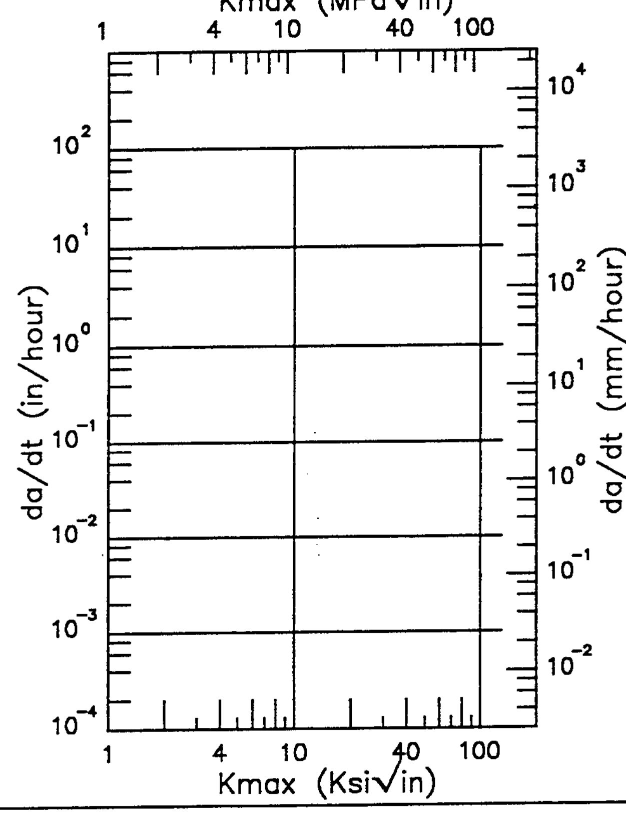
18NI(350)

Condition/Ht: AGED 8HR 800F
Form:
Specimen Type: NB – 3 pt
Orientation:
Yield Strength: 330 ksi
Ult. Strength:

Specimen Thk: 0.394 in.
Specimen Width: 0.394 in.
Ao:
KIscc:
Ref: 74719

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
13.00 (min)	392.
16.	930.
20.	1502.
25.	2053.
30.	2898.
32.00 (max)	3454.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error
11.26

RMS % Error

Figure 3.11.3.2

TABLE 3.12.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 18Ni(350)(MAR)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1500°F 1hr; 800°F 8hr	F	R.T.	L-S	299	3.5% NaCl	---	0.394	0.394	4	---	70.1	5	---	1969	75677
1500°F 1hr; 900°F 8hr	F	R.T.	L-S	325	3.5% NaCl	---	0.394	0.394	4	---	35	10	---	1969	75677
1500°F 1hr; 950°F 3hr	F	R.T.	L-S	325	3.5% NaCl	---	0.394	0.394	4	---	40	10	---	1969	75677
Age 800°F 8hr	FB	R.T.	---	299	3.5% NaCl	CHAR	0.394	0.394	---	---	30	5	---	1971	84351
Age 900°F 3hr	FB	R.T.	---	330	3.5% NaCl	CHAR	0.394	0.394	---	---	42	10	---	1971	84351
Age 900°F 8hr	FB	R.T.	---	335	3.5% NaCl	CHAR	0.394	0.394	---	---	36	10	---	1971	84351

TABLE 3.13.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 300M AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$ Specimen Orientation L-T Mean K_{Ic}	L-T Std Dev	L-T n	T-L Mean K_{Ic}	T-L Std Dev	T-L n	S-L Mean K_{Ic}	S-L Std Dev	S-L n
Plate	1700F 1HR AC 1600F 1HR OQ 600F 2HR AC (AMS 6419)	51.8	0.7	3	---	---	---	---	---	---
	HEAT TREATED TO 54 RC HARDNESS	---	---	---	58.6	3.5	2	---	---	---
Forging	1600F 1.25 HR OQ 600F 2+2HR	54.6	2.5	4	50.6	1.7	2	54.1	1.1	4
	Unspecified	52.6	2.3	4	52.9	2.	4	---	---	---
Bar	2190F 1HR FC TO 1600F HOLD 0.5HR OQ 475F 1HR	47.9	3.8	2	---	---	---	---	---	---

TABLE 3.13.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=280-300KSI	BILLET	0.	1				4.2	105.32	
		0.	10				2.24	100.5	

TABLE 3.13.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: L-T

ENVIRONMENT: Alt Immersion Seawater - Immersion

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=280-300KSI	BILLET	0.	1				7.06	50.57	
		0.	10				2.17		

TABLE 3.13.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: L-T

ENVIRONMENT: Alt Immersion Seawater - 1st Half Dry Cycle

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=280-300KSI	BILLET	0.	1				2.61		
		0.	10				2.05		

TABLE 3.13.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
300M AT ROOM TEMPERATURE

ORIENTATION: L-T

ENVIRONMENT: Alt Immersion Seawater - 2nd Half Dry Cycle

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=280-300KSI	BILLET	0.	10				2.48		
		0.	1-10				5.74		

TABLE 3.13.1.2.5

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS	FORGING	0.08	1				3.67		
		0.08	6			0.65	4.03		
		0.3	6				4.75		
		0.5	6			0.9	6.83		
UTS=280-300KSI	BILLET	-1	10				3.18	187.62	
		0.	10				2.96	37.96	
		0.5	10			0.65	5.39		

TABLE 3.13.1.2.6

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level (Ksi√in)*					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=280-300KSI	BAR	-1	10				3.65	38.07	
		0.02	10				3.52	47.71	
		0.5	10			1	6.55		
UNSPECIFIED	FORGING	0.02	1-15			0.66	4.24		
		0.02	0.1-20			0.67	4.26	104.94	

TABLE 3.13.1.2.7

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*) 2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	1-5					348.82	
		0.02	1-20			0.74	3.38	149.82	

TABLE 3.13.1.2.8

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS	FORGING	0.08	6				4.1		

TABLE 3.13.1.2.9

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-20		0.14	0.7	4.35	156.19	

TABLE 3.13.1.2.10

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-20			0.78	3.36		

TABLE 3.13.1.2.11

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS	FORGING	0.08	1			4.28			

TABLE 3.13.1.2.12

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 300M AT ROOM TEMPERATURE

ORIENTATION: S-L **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				Δ*K Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS	FORGING	0.08	6				4.09		

TABLE 3.13.2.1

ALLOY STEEL 300M K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_Q (Ksi • √in.)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
---	Forging	1.25	R.T.	L-T	239.0	2.504	1.267	CT	1.293	0.12	53.59	52.6	2.3	1977	MA005
		1.25			239.0	2.509	1.249	CT	1.279	0.13	55.50			1977	MA005
		1.25			246.5	2.505	1.251	CT	1.267	0.10	50.80			1977	MA005
		1.25			246.5	2.490	1.251	CT	1.286	0.10	50.70			1977	MA005
---	Forging	1.25	R.T.	T-L	240.0	2.496	1.256	CT	1.271	0.13	55.50	52.9	2.0	1977	MA005
		1.25			240.0	2.512	1.254	CT	1.288	0.12	53.50			1977	MA005
		1.25			246.5	2.507	1.247	CT	1.228	0.10	51.70			1977	MA005
		1.25			246.5	2.508	1.252	CT	1.296	0.10	50.90			1977	MA005
1600F 0.5 HR SQ 1000F 0.5-1.0 HR OQ 80-180F 25MIN 575F 2+2HR	Forging	5.50	-65	---	245.0	1.501	0.750	CT	0.734	0.07	41.50	46.0	3.9	1970	84280 (1)
		5.50			245.0	1.503	0.750	CT	0.758	0.10	48.00			1970	84280 (1)
		5.50			245.0	1.505	0.747	CT	0.752	0.10	48.40			1970	84280 (1)
1600F 0.5 HR SQ 1000F 0.5-1.0 HR OQ 80-180F 25MIN 575F 2+2HR	Forging	5.50	0	---	231.0	1.499	0.745	CT	0.735	0.14	55.30	57.1	1.7	1970	84280 (1)
		5.50			231.0	1.503	0.746	CT	0.742	0.16	58.70			1970	84280 (1)
		5.50			231.0	1.501	0.750	CT	0.736	0.15	57.20			1970	84280 (1)
1600F 0.5 HR SQ 1000F 0.5-1.0 HR OQ 80-180F 25MIN 575F 2+2HR	Forging	5.50	R.T.	---	230.0	1.501	0.749	CT	0.737	0.19	64.30	64.9	0.7	1970	84280 (1)
		5.50			230.0	1.499	0.750	CT	0.735	0.20	64.60			1970	84280 (1)
		5.50			230.0	1.504	0.750	CT	0.739	0.20	65.70			1970	84280 (1)
1600F 0.5 HR SQ 1000F 0.5-1.0 HR OQ 80-180F 25MIN 575F 2+2HR	Forging	5.50	200	---	220.0	1.502	0.749	CT	0.729	0.25	68.90	68.2	0.6	1970	84280 (1)
		5.50			220.0	1.500	0.746	CT	0.734	0.24	67.70			1970	84280 (1)
		5.50			220.0	1.499	0.745	CT	0.734	0.24	68.10			1970	84280 (1)

TABLE 3.13.2.1 (CONTINUED)

ALLOY STEEL 300M K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	L-T	237.0	1.002	0.247	CT	0.491	0.15	56.10	54.6	2.5	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	L-T	237.0	1.002	0.247	CT	0.495	0.15	57.10	54.6	2.5	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	L-T	237.0	1.000	0.249	CT	0.495	0.13	51.50	54.6	2.5	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	L-T	237.0	1.002	0.248	CT	0.502	0.14	53.80	54.6	2.5	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	T-L	240.0	1.002	0.248	CT	0.507	0.13	51.80	50.6	1.7	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	T-L	240.0	0.987	0.247	CT	0.492	0.12	49.40	50.6	1.7	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	S-L	230.0	1.005	0.248	CT	0.496	0.14	55.10	54.1	1.1	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	S-L	230.0	1.002	0.248	CT	0.497	0.13	52.80	54.1	1.1	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	S-L	230.0	1.004	0.247	CT	0.504	0.14	54.90	54.1	1.1	1973	85836
1600F 1.25 HR OQ 600F 2+2HR	Forging	3.00	R.T.	S-L	230.0	1.000	0.248	CT	0.485	0.14	53.60	54.1	1.1	1973	85836
1600F 1HR OQ 1HR WQ 475 1HR	Bar	0.62	R.T.	L-T	240.0	2.000	0.600	CT	1.000	0.05	34.30	---	---	1973	87241 (1)
1600F 1HR OQ 475F 1HR	Bar	0.62	R.T.	L-T	240.0	2.000	0.600	CT	1.000	0.05	34.80	---	---	1973	87241 (1)
1600F 1HR OQ 575F 1HR	Bar	0.62	R.T.	L-T	245.0	2.000	0.600	CT	1.000	0.15	59.40	---	---	1973	87241 (1)
1600F 1HR OQ 615F 1HR	Bar	0.62	R.T.	L-T	245.0	2.000	0.600	CT	1.000	0.15	60.90	---	---	1973	87241 (1)
1600F 1HR OQ 745F 1HR	Bar	0.62	R.T.	L-T	245.0	2.000	0.600	CT	1.000	0.17	64.80	---	---	1973	87241
1600F OQ 550F 2+2HR	Plate	0.56	R.T.	L-T	235.0	1.500	0.500	NB	---	0.20	66.00	---	---	1970	78305 (2)
1675F AC 1575F OQ 1100F 2 HR (RC 39)	Plate	1.00	R.T.	---	200.0	1.997	1.012	CT	1.137	0.42	81.50	81.4	3.7	1973	85883 (3)
1675F AC 1575F OQ 1100F 2 HR (RC 39)	Plate	1.00	R.T.	---	200.0	1.989	1.010	CT	1.139	0.45	84.80	81.4	3.7	1973	85883 (3)
1675F AC 1575F OQ 1100F 2 HR (RC 39)	Plate	1.00	R.T.	---	200.0	1.996	1.010	CT	1.123	0.43	82.90	81.4	3.7	1973	85883 (3)
1675F AC 1575F OQ 1100F 2 HR (RC 39)	Plate	1.00	R.T.	---	200.0	2.000	1.009	CT	1.103	0.36	76.20	81.4	3.7	1973	85883 (3)
1675F AC 1575F OQ 500F 2 HR (RC 51.5)	Plate	1.00	R.T.	---	240.0	1.995	1.010	CT	1.054	0.09	46.20	49.1	3.6	1973	85883 (3)
1675F AC 1575F OQ 500F 2 HR (RC 51.5)	Plate	1.00	R.T.	---	240.0	2.001	1.010	CT	1.092	0.12	52.60	49.1	3.6	1973	85883 (3)

TABLE 3.13.2.1 (CONCLUDED)

ALLOY STEEL 300M K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}: K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic}: K_{Ic} MEAN	K_{Ic}: STAN DEV	DATE	REFER
1675F AC 1575F OQ 500F 2 HR (RC 51.5) Cont'd	Plate Cont'd	1.00	R.T. Cont'd	--- Cont'd	240.0	2.001	1.010	CT	1.147	0.09	45.90	Cont'd	Cont'd	1973	85883 (1)
		1.00			240.0	1.996	1.010	CT	1.065	0.12	51.80			1973	85883 (1)
1675F AC 1575F OQ 800F 2HR (RC 47.5)	Plate	1.00	R.T.	---	220.0	1.998	1.010	CT	1.122	0.13	50.10	49.2	1.3	1973	85883 (1)
		1.00			220.0	1.995	1.010	CT	1.081	0.13	49.60			1973	85883 (1)
		1.00			220.0	1.988	1.010	CT	1.088	0.12	47.30			1973	85883 (1)
		1.00			220.0	1.994	1.010	CT	1.068	0.13	49.80			1973	85883 (1)
1700F 1HR AC 1600F 1HR OQ 600F 2HR AC	Plate	1.00	R.T.	L-T	236.0	1.000	0.500	NB	0.490	0.12	52.40	51.8	0.7	1974	88136
		1.00			236.0	0.995	0.502	NB	0.491	0.12	51.00			1974	88136
		1.00			236.0	0.991	0.501	NB	0.485	0.12	52.00			1974	88136
2190F 1HR FC TO 1600F HOLD 0.5HR OQ 475F 1HR	Bar	0.62	R.T.	L-T	235.0	2.000	0.600	CT	1.000	0.12	50.60	47.9	3.8	1973	87241
		0.62			235.0	2.000	0.600	CT	1.000	0.09	45.20			1973	87241
2190F 1HR FC TO 1600F HOLD 0.5HR OQ 615F 1HR	Bar	0.62	R.T.	L-T	240.0	2.000	0.600	CT	1.000	0.12	52.70	---	---	1973	87241
2190F 1HR FC TO 1600F HOLD 0.5HR OQ 745F 1 HR	Bar	0.62	R.T.	L-T	240.0	2.000	0.600	CT	1.000	0.18	63.50	---	---	1973	87241
2190F 1HR OQ 400F 1HR	Bar	0.62	R.T.	L-T	219.0	2.000	0.600	CT	1.000	0.29	75.00	---	---	1973	87241
2190F 1HR OQ 475F 1 HR	Bar	0.62	R.T.	L-T	230.0	2.000	0.600	CT	1.000	0.23	69.20	---	---	1973	87241
2190F 1HR OQ 475F 1HR WQ 475F 1HR	Bar	0.62	R.T.	L-T	232.0	2.000	0.600	CT	1.000	0.24	71.80	---	---	1973	87241
2190F 1HR OQ 615F 1HR	Bar	0.62	R.T.	L-T	236.0	2.000	0.600	CT	1.000	0.26	75.50	---	---	1973	87241
2190F 1HR OQ 745F 1HR	Bar	0.62	R.T.	L-T	240.0	2.000	0.600	CT	1.000	0.24	74.70	---	---	1973	87241
HEAT TREATED TO 54 RC HARDNESS	Plate	1.00	R.T.	T-L	250.0	0.904	0.447	NB	0.485	0.12	56.10	58.6	3.5	1971	84029 (2)
		1.00			250.0	0.903	0.448	NB	0.473	0.15	61.10			1971	84029 (2)

TABLE 3.13.2.2

300M K_C

CONDITION HEAT TREAT	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN		CRACK LENGTH		GROSS STRESS		K_{app}			K_C			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	INIT (in.) $2a_o$	FINAL (in.) $2a_f$	ONSET (Ksi) σ_o	MAX (Ksi) σ_{Max}	K_{app} (Ksi$\sqrt{in.}$)	K_{app} MEAN	STAN DEV	K_Q (Ksi$\sqrt{in.}$)	K_Q MEAN	STAN DEV		
BUCKLING OF CRACK EDGES RESTRAINED																			
AMS 6434 UTS = 280-300 Ksi	Sheet	0.13	R.T.	L-T	239.0	5.000	0.119	1.880	---	---	71.10	134.06	142.4	11.8	---	---	---	1968	73988
		0.13			239.0	5.000	0.123	2.530	---	---	63.30	150.78			---			1968	73988
AMS 6434 UTS = 280-300 Ksi	Sheet	0.13	R.T.	L-T	239.0	5.000	0.130	1.170	---	---	98.60	138.37	---	---	---	---	---	1968	73988
BUCKLING OF CRACK EDGES NOT RESTRAINED																			
AMS 6434 UTS = 220-240 Ksi	Plate	0.38	R.T.	L-T	209.0	5.000	0.370	1.750	---	---	36.10	64.82	71.1	7.2	---	---	---	1968	73988
		0.38			209.0	5.000	0.370	1.850	---	---	35.90	66.94			---			1968	73988
		0.38			209.0	5.000	0.371	1.320	---	---	43.20	65.02			---			1968	73988
		0.38			209.0	5.000	0.372	2.500	---	---	30.30	71.41			---			1968	73988
		0.38			209.0	5.000	0.374	1.300	---	---	50.40	75.18			---			1968	73988
		0.38			209.0	5.000	0.374	2.440	---	---	36.10	83.27			---			1968	73988
AMS 6434 UTS = 260-280 Ksi	Plate	0.38	R.T.	L-T	234.0	5.000	0.368	1.710	---	---	44.30	78.33	71.4	7.0	---	---	---	1968	73988
		0.38			234.0	5.000	0.369	2.080	---	---	33.00	66.94			---			1968	73988
		0.38			234.0	5.000	0.370	1.240	---	---	52.40	76.04			---			1968	73988
		0.38			234.0	5.000	0.371	2.500	---	---	27.00	63.63			---			1968	73988
		0.38			234.0	5.000	0.372	1.380	---	---	41.90	64.76			---			1968	73988
		0.38			234.0	5.000	0.374	2.540	---	---	32.80	78.41			---			1968	73988
AMS 6434 UTS = 280-300 Ksi	Plate	0.38	R.T.	L-T	238.0	5.000	0.372	1.900	---	---	46.40	88.14	84.1	3.7	---	---	---	1968	73988
		0.38			238.0	5.000	0.372	2.280	---	---	38.30	83.46			---			1968	73988
		0.38			238.0	5.000	0.372	1.050	---	---	61.20	80.81			---			1968	73988

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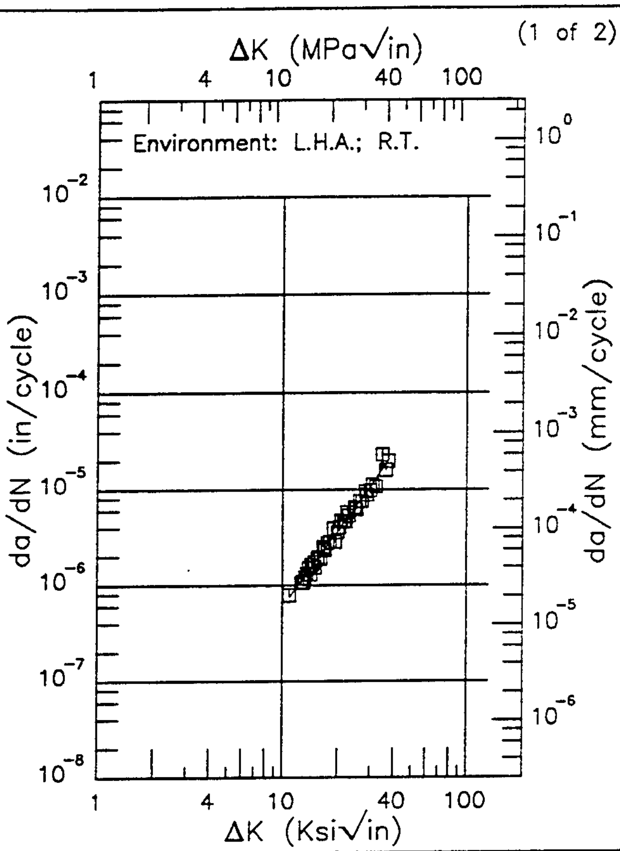
E 300M

Condition/Ht: 1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS
Form: 3 in. Forging
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 1 – 6 Hz

Yield Strength: 238 ksi
Ult. Strength: 287 ksi
Specimen Thk: 1 in.
Specimen Width: 7.4 in.
Ref: RI006

(1 of 2)



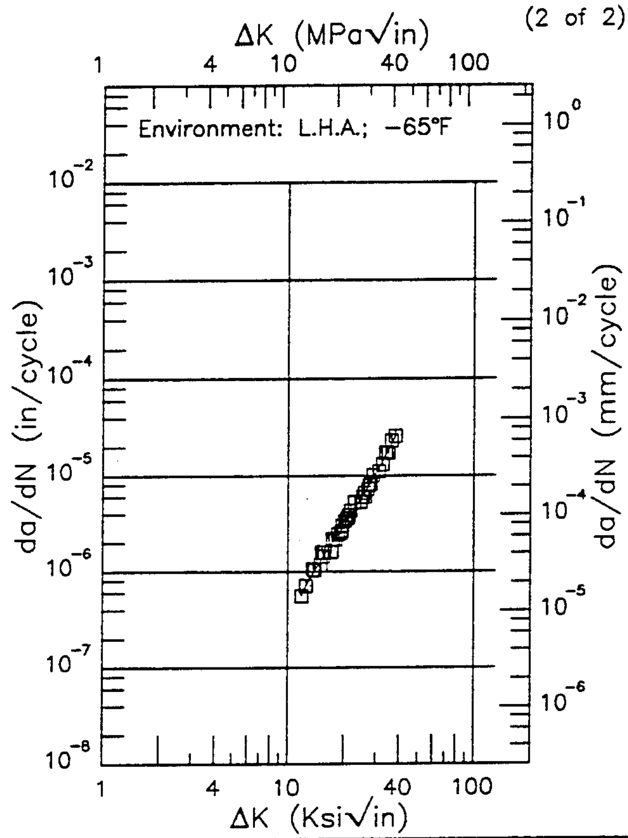
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.87 (min)	0.744
13.	1.20
16.	2.05
20.	3.67
25.	6.62
30.	10.9
35.	16.8
37.57 (max)	20.6

RMS % Error 10.89

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.83 (min)	0.577
13.	0.803
16.	1.56
20.	3.04
25.	5.93
30.	10.7
35.	18.7
38.05 (max)	26.0

RMS % Error 7.38

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.13.3.1.1

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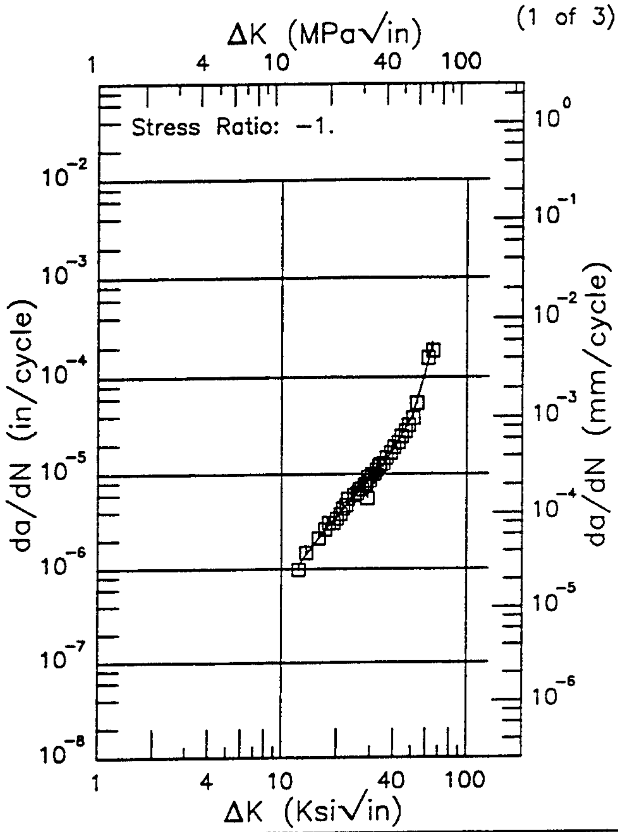
R

300M

Condition/Ht: UTS=280–300KSI
Form: 4.25 in. Bar
Specimen Type: CCP (max load specified)
Orientation: L–T
Frequency: 10 Hz
Environment: LAB AIR; RT

Yield Strength: 234.5 ksi
Ult. Strength: 282.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 4 in.
Ref: MA006

(1 of 3)



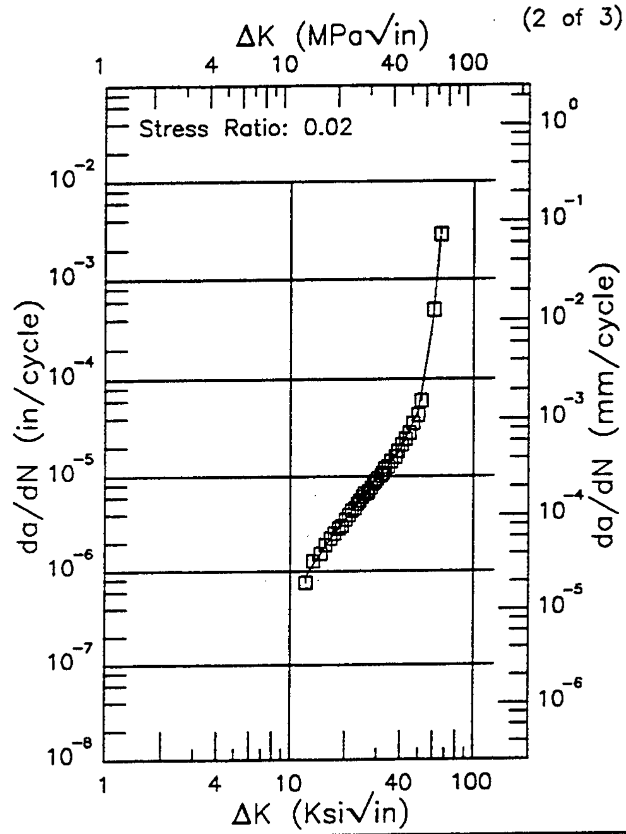
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.40 (min)	1.07
13.	1.23
16.	2.15
20.	3.65
25.	5.99
30.	8.97
35.	12.8
40.	17.9
50.	38.1
60.	116.
64.78 (max)	230.

RMS % Error
8.24

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.11 (min)	0.858
13.	1.07
16.	1.96
20.	3.52
25.	6.07
30.	9.34
35.	13.5
40.	18.6
50.	47.7
60.	388.
66.09 (max)	2695.

RMS % Error
4.95

Life Prediction Ratio Summary

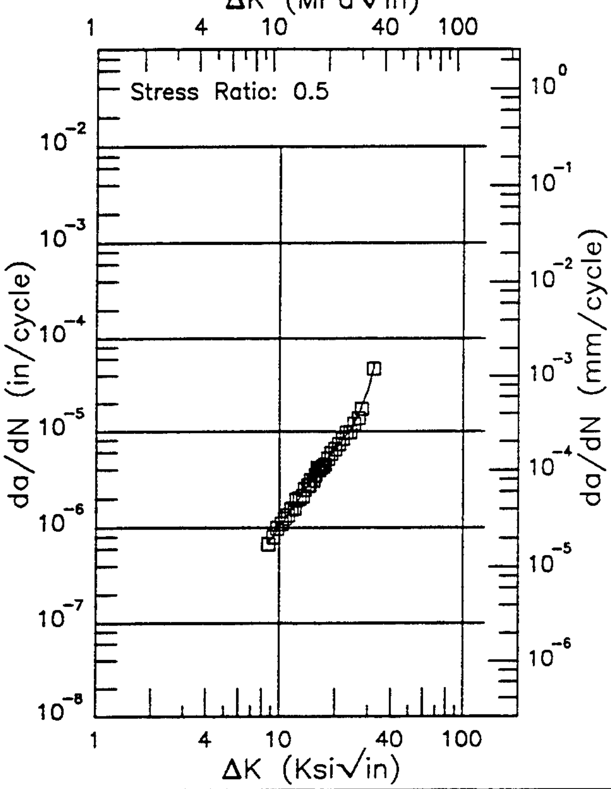
0. .5 .8 1.25 2.

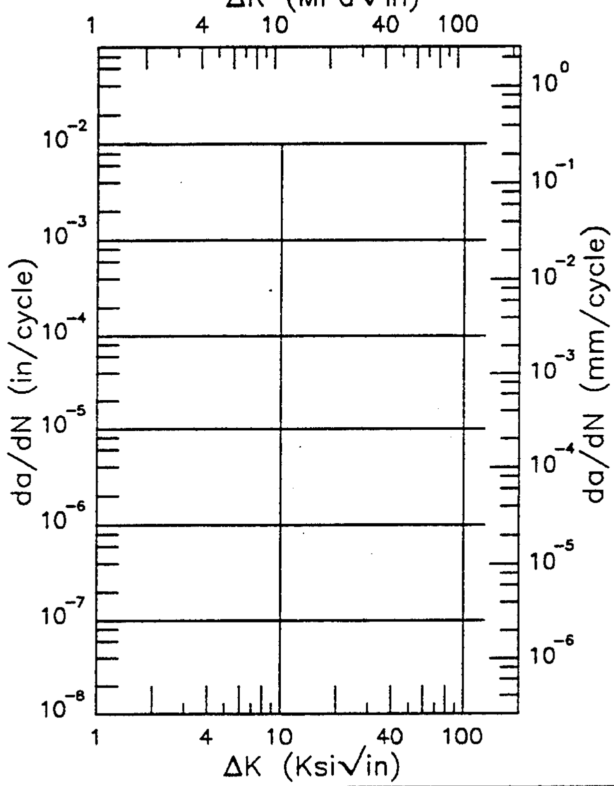
Figure 3.13.3.1.2

Condition/Ht: UTS=280–300KSI
Form: 4.25 in. Bar
Specimen Type: CCP (max load specified)
Orientation: L–T
Frequency: 10 Hz
Environment: LAB AIR; RT

Yield Strength: 234.5 ksi
Ult. Strength: 282.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 4 in.
Ref: MA006

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.73 (min)	0.699
9.	0.756
10.	1.00
13.	2.10
16.	3.74
20.	6.55
25.	11.5
30.	28.1
31.97 (max)	45.9

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
4.35	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

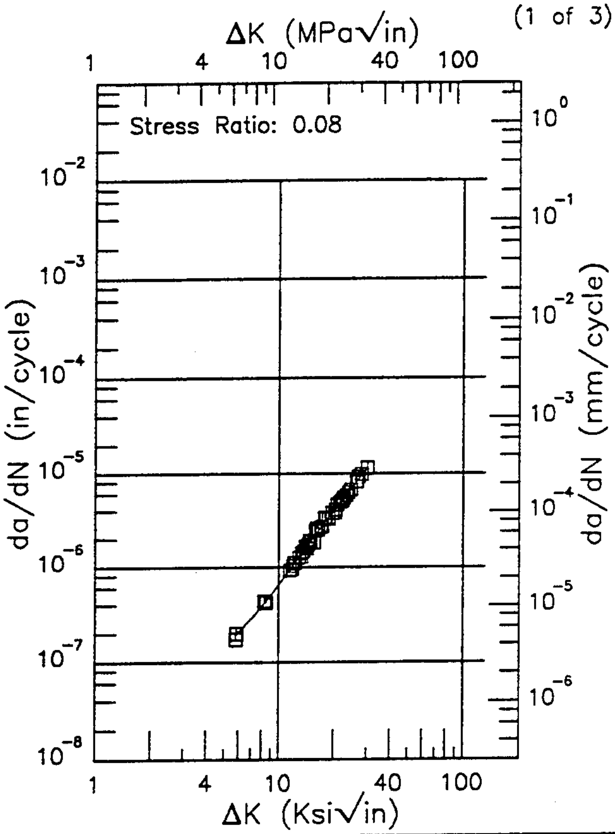
Figure 3.13.3.1.2 (Concluded)

R 300M

Condition/Ht: 1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS
Form: 3 in. Forging
Specimen Type: CT
Orientation: L–T
Frequency: 6 Hz
Environment: L.H.A.; RT

Yield Strength: 238 ksi
Ult. Strength: 287 ksi
Specimen Thk: 1 in.
Specimen Width: 7.4 in.
Ref: RI006

(1 of 3)



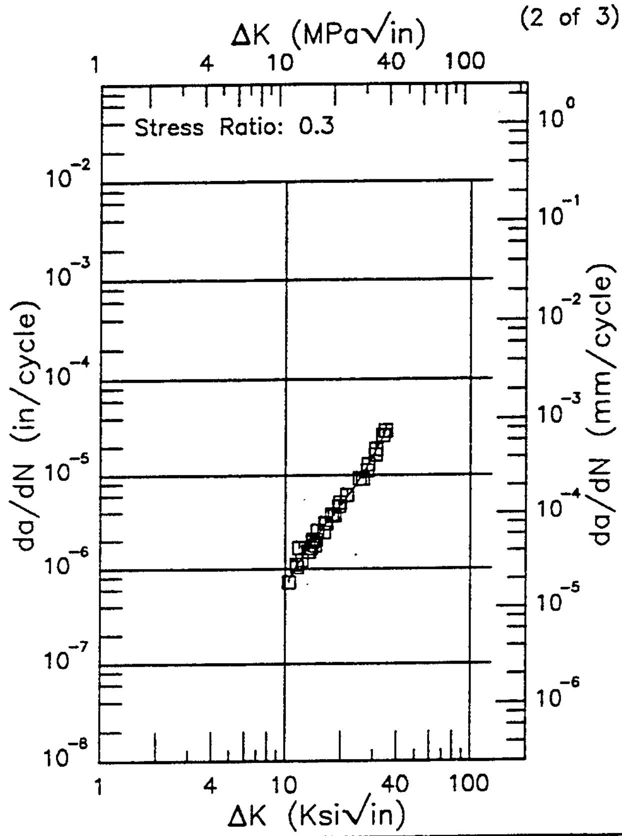
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.76 (min)	0.191
6.	0.206
7.	0.283
8.	0.381
9.	0.503
10.	0.651
13.	1.28
16.	2.22
20.	4.03
25.	7.18
30.	11.2
30.13 (max)	11.4

RMS % Error 5.20

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.47 (min)	0.760
13.	1.55
16.	2.72
20.	4.75
25.	8.72
30.	15.8
34.66 (max)	28.2

RMS % Error 10.83

Life Prediction Ratio Summary

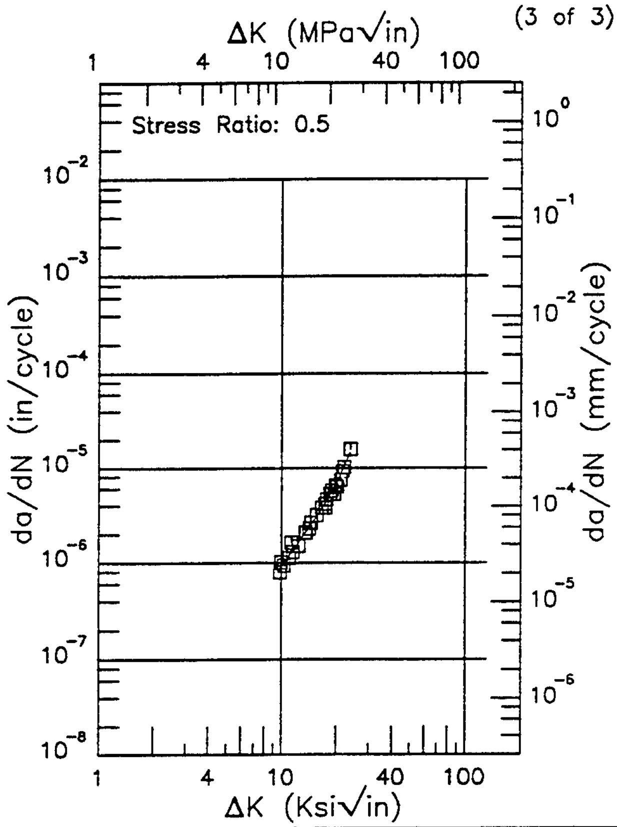
0. .5 .8 1.25 2.

Figure 3.13.3.1.3

Condition/Ht: 1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS
Form: 3 in. Forging
Specimen Type: CT
Orientation: L–T
Frequency: 6 Hz
Environment: L.H.A.; RT

Yield Strength: 238 ksi
Ult. Strength: 287 ksi
Specimen Thk: 1 in.
Specimen Width: 7.4 in.
Ref: R1006

(3 of 3)

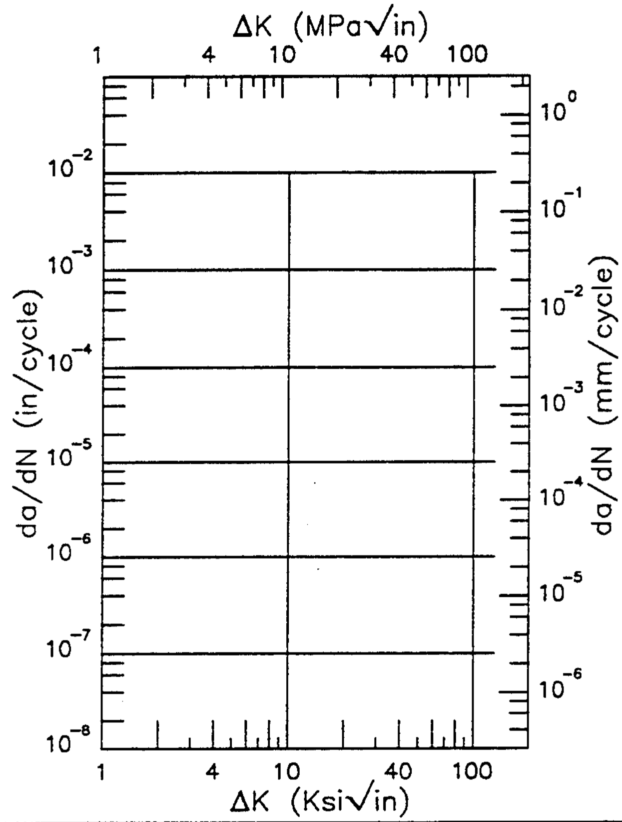


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.74 (min)	0.832
10.	0.901
13.	1.84
16.	3.23
20.	6.83
23.72 (max)	14.6

RMS % Error
8.76

Life Prediction Ratio Summary

0. .5 .8 1.25 2.



ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

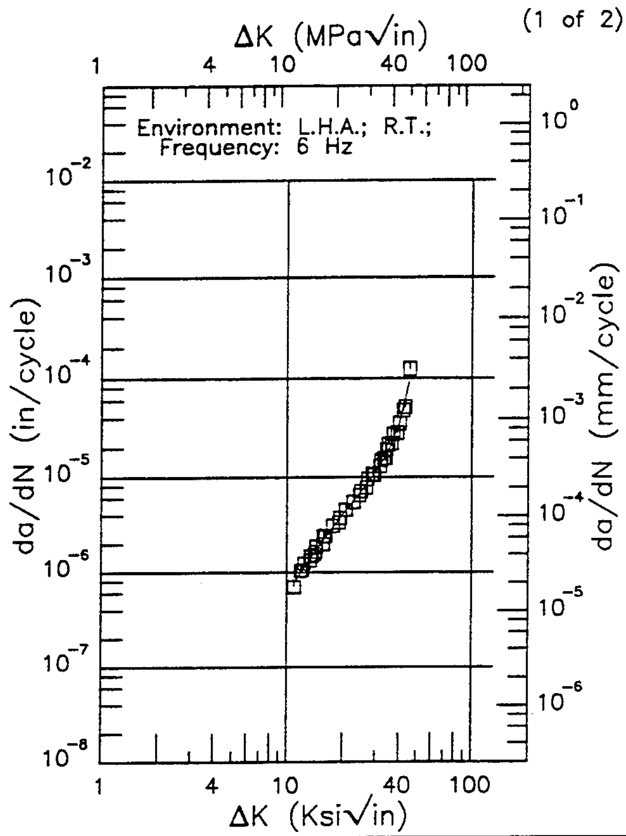
Figure 3.13.3.1.3 (Concluded)

EF — 300M

Condition/Ht: 1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS

Form: 3 in. Forging	Yield Strength: 236 ksi
Specimen Type: CT	Ult. Strength: 281 ksi
Orientation: T-L	Specimen Thk: 1 in.
Stress Ratio: 0.08	Specimen Width: 7.4 in.
	Ref: RI006

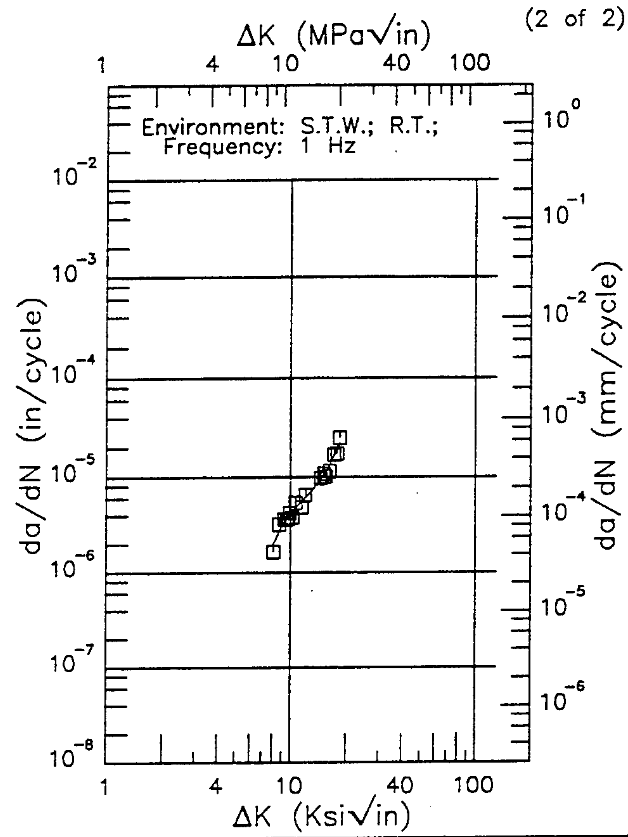
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.91 (min)	0.760
13.	1.31
16.	2.33
20.	4.10
25.	7.11
30.	11.3
35.	18.6
40.	36.0
45.45 (max)	93.0

RMS % Error	Life Prediction Ratio Summary
8.65	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.05 (min)	1.93
9.	3.13
10.	4.28
13.	7.12
16.	12.0
18.47 (max)	22.5

RMS % Error	Life Prediction Ratio Summary
10.13	0. .5 .8 1.25 2.

Figure 3.13.3.1.4

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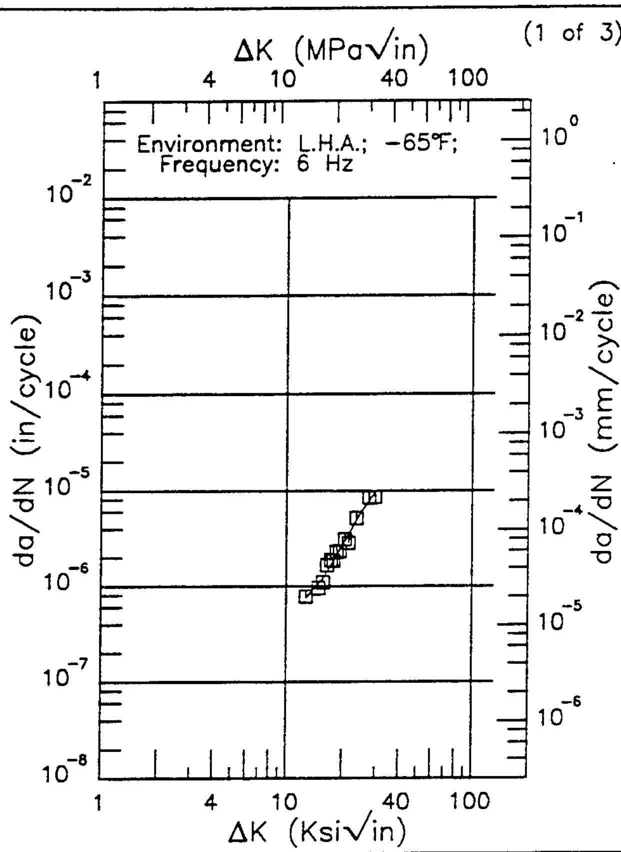
EF 300M

Condition/Ht: 1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS
Form: 3 in. Forging
Specimen Type: CT
Orientation: S-L
Stress Ratio: 0.08

Yield Strength:
Ult. Strength:
Specimen Thk: 1 in.
Specimen Width: 3.1 in.
Ref: RI006

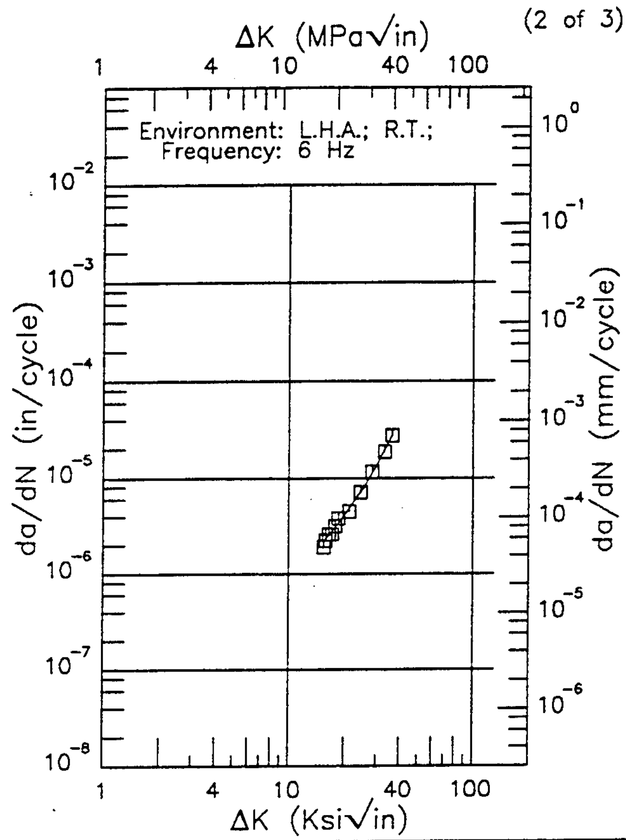
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.73 (min)	0.751
13.	0.775
16.	1.27
20.	2.72
25.	5.91
29.53 (max)	9.36

RMS % Error	Life Prediction Ratio Summary
10.73	0. .5 .8 1.25 2.

(2 of 3)



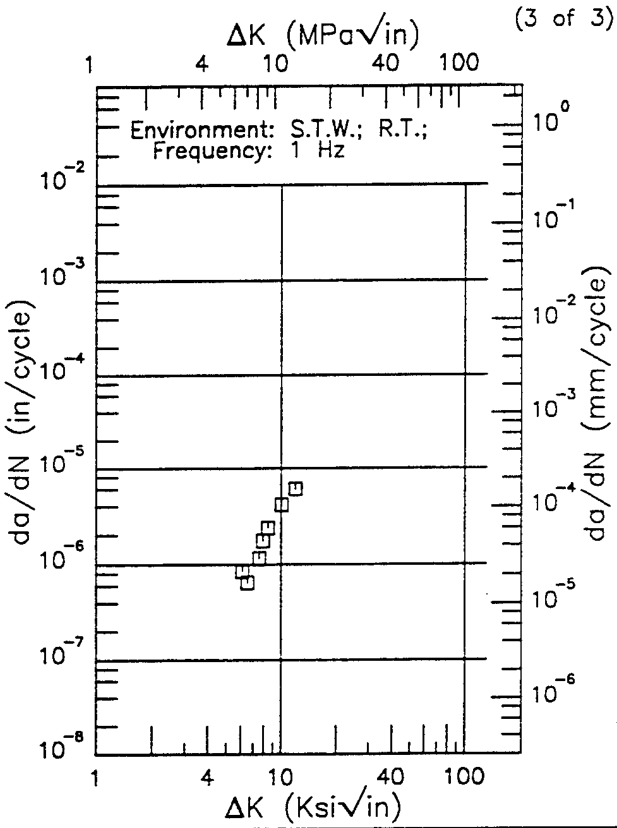
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.42 (min)	2.08
16.	2.29
20.	4.09
25.	7.59
30.	13.6
35.	24.2
36.05 (max)	27.3

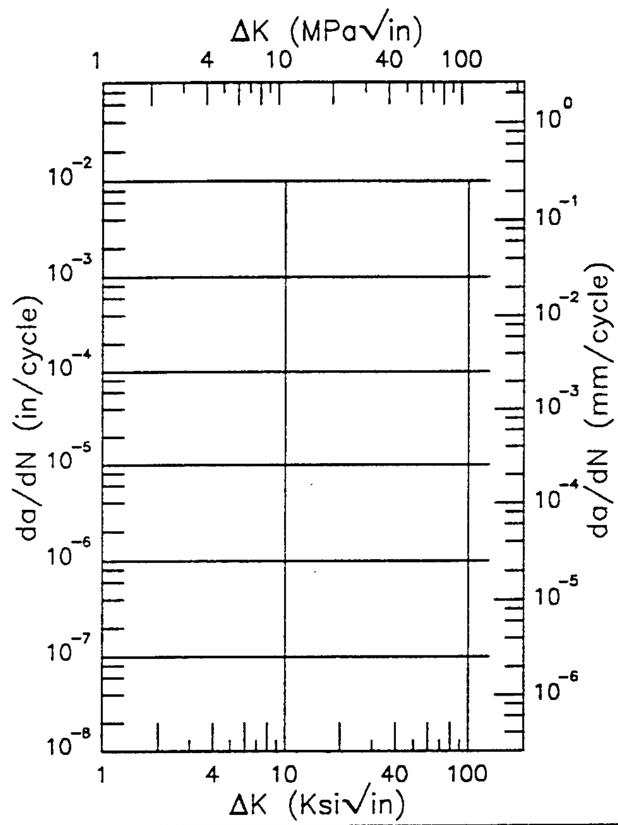
RMS % Error	Life Prediction Ratio Summary
6.11	0. .5 .8 1.25 2.

Figure 3.13.3.1.5

Condition/Ht: 1700F 1.5HRS AC 1600F 1.5HRS OQ 600F 2+2HRS
Form: 3 in. Forging
Specimen Type: CT
Orientation: S-L
Stress Ratio: 0.08
Yield Strength:
Ult. Strength:
Specimen Thk: 1 in.
Specimen Width: 3.1 in.
Ref: RI006

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.13.3.1.5 (Concluded)

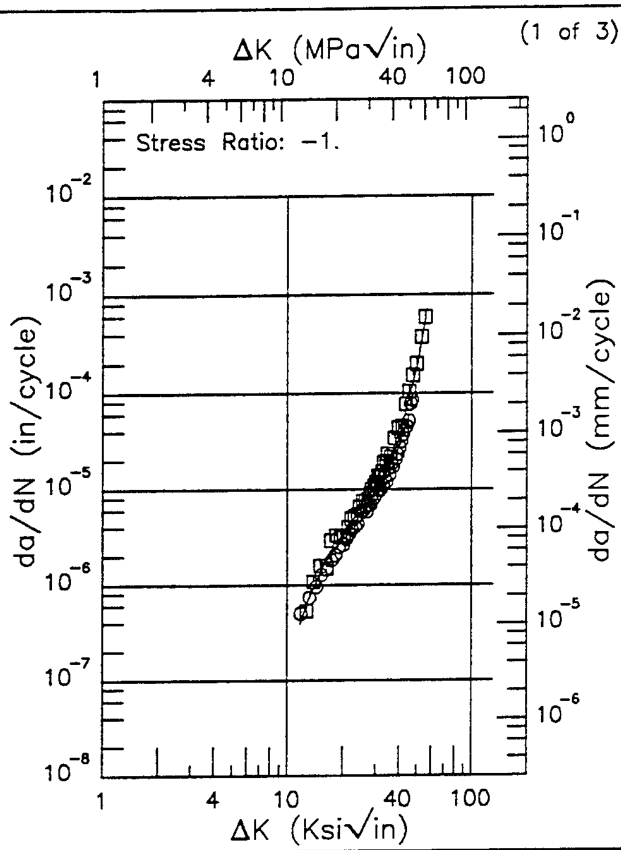
R

300M

Condition/Ht: UTS=280–300KSI
Form: 3.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L–T
Frequency: 10 Hz
Environment: L.H.A.; RT

Yield Strength: 248 – 250 ksi
Ult. Strength: 295.5 – 298 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 – 4 in.
Ref: MA007;MA010

(1 of 3)



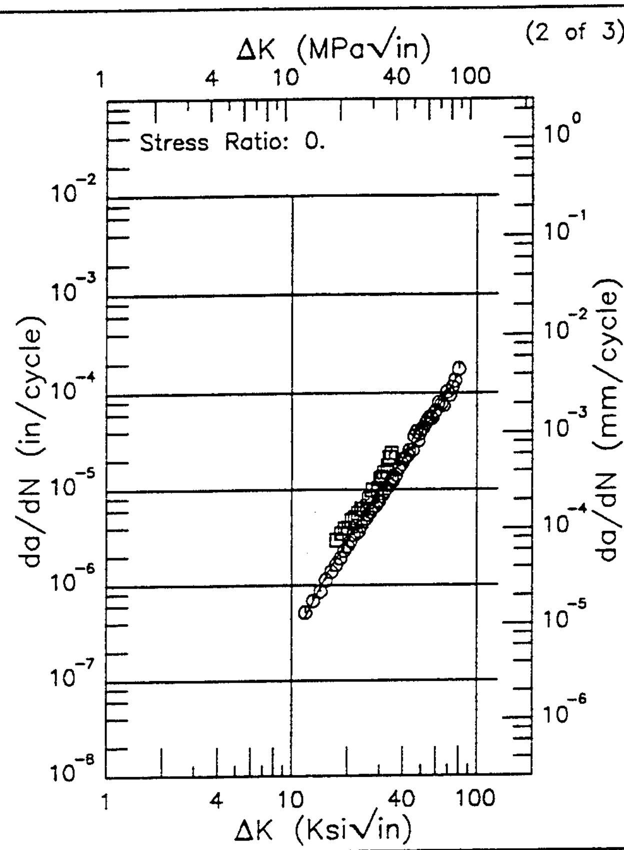
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.81 (min)	0.390
13.	0.684
16.	1.67
20.	3.18
25.	5.47
30.	9.27
35.	17.0
40.	34.4
50.	188.
55.73 (max)	573.

RMS % Error
20.73

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.83 (min)	0.455
13.	0.664
16.	1.42
20.	2.96
25.	5.73
30.	9.53
35.	14.5
40.	20.7
50.	38.0
60.	63.8
70.	102.
79.71 (max)	154.

RMS % Error
22.02

Life Prediction Ratio Summary

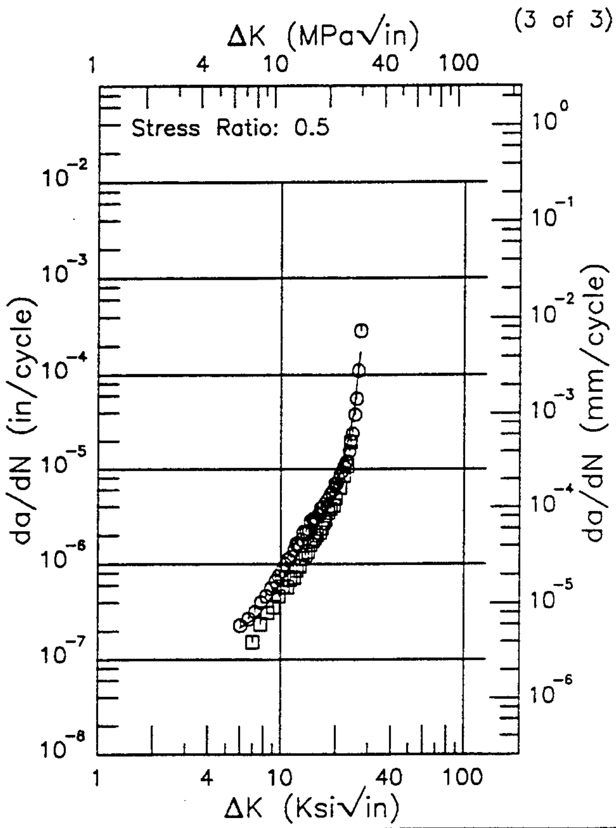
0. .5 .8 1.25 2.

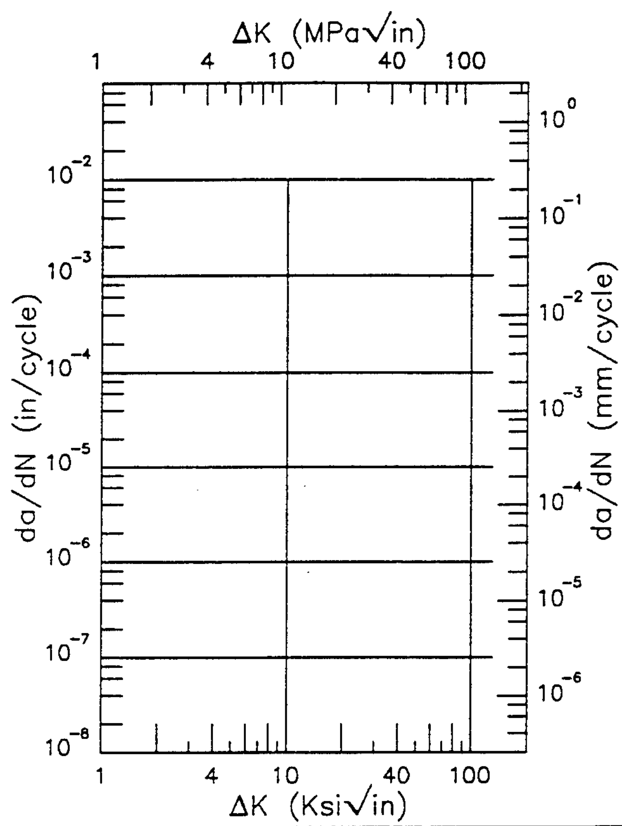
Figure 3.13.3.1.6

Condition/Ht: UTS=280–300KSI
Form: 3.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L–T
Frequency: 10 Hz
Environment: L.H.A.; RT

Yield Strength: 248 – 250 ksi
Ult. Strength: 295.5 – 298 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 – 4 in.
Ref: MA007;MA010

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.00 (min)	0.216
6.	0.216
7.	0.258
8.	0.341
9.	0.468
10.	0.647
13.	1.53
16.	2.82
20.	5.39
25.	40.1
27.15 (max)	174.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error 25.79

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

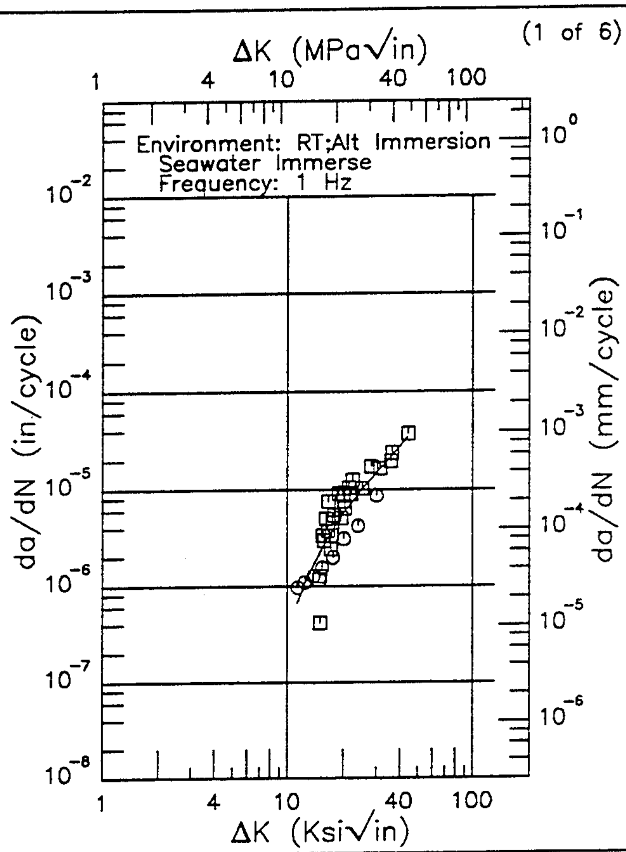
Figure 3.13.3.1.6 (Concluded)

EF 300M

Condition/Ht: UTS=280–300KSI
Form: 3.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L–T
Stress Ratio: 0.

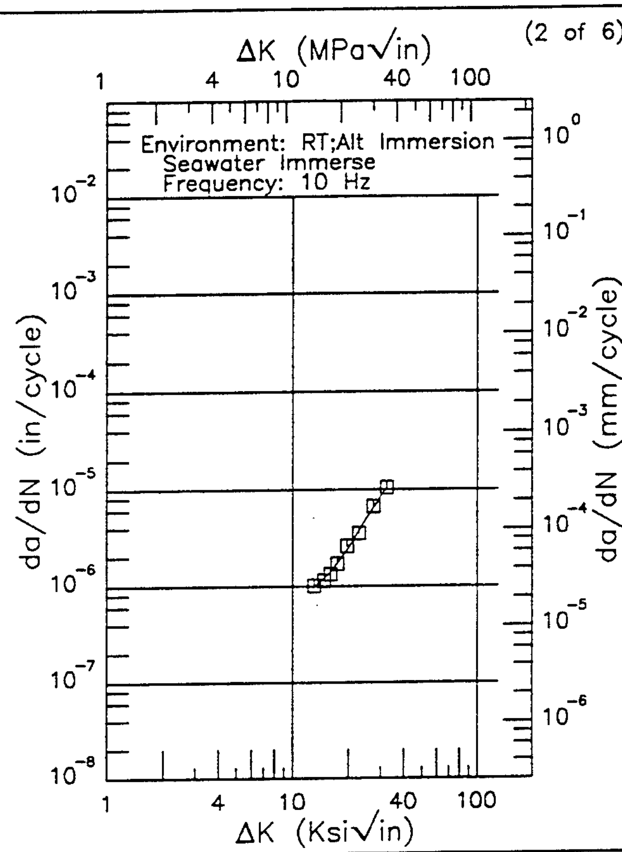
Yield Strength: 248 ksi
Ult. Strength: 295.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 in.
Ref: MA010

(1 of 6)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.30 (min)	0.672
13.	1.29
16.	2.89
20.	5.74
25.	10.0
30.	15.0
35.	20.8
40.	27.7
44.10 (max)	34.5

(2 of 6)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.03 (min)	0.971
16.	1.37
20.	2.48
25.	4.93
30.	8.54
32.23 (max)	10.4

RMS % Error	Life Prediction Ratio Summary
46.56	0. .5 .8 1.25 2.

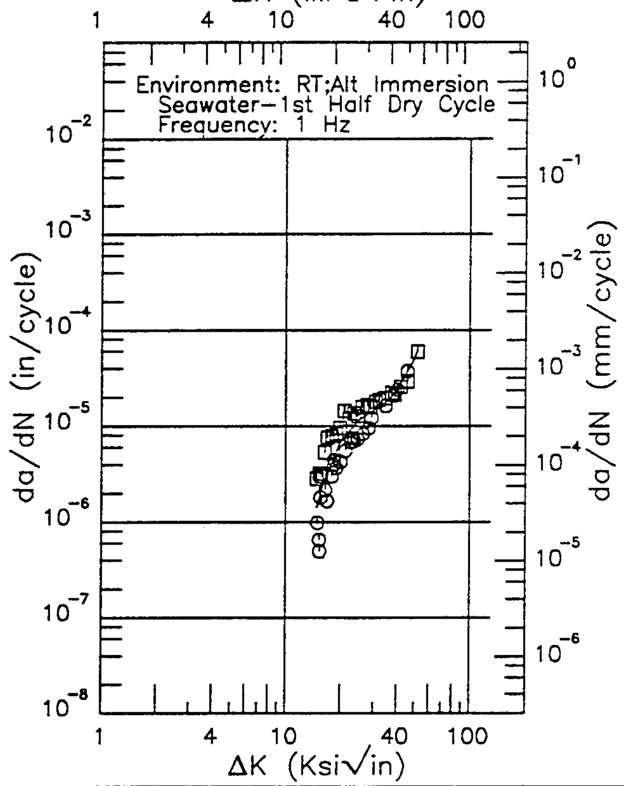
RMS % Error	Life Prediction Ratio Summary
4.34	0. .5 .8 1.25 2.

Figure 3.13.3.1.7

Condition/Ht: UTS=280-300KSI
Form: 3.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L-T
Stress Ratio: 0.

Yield Strength: 248 ksi
Ult. Strength: 295.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 in.
Ref: MA010

(3 of 6)



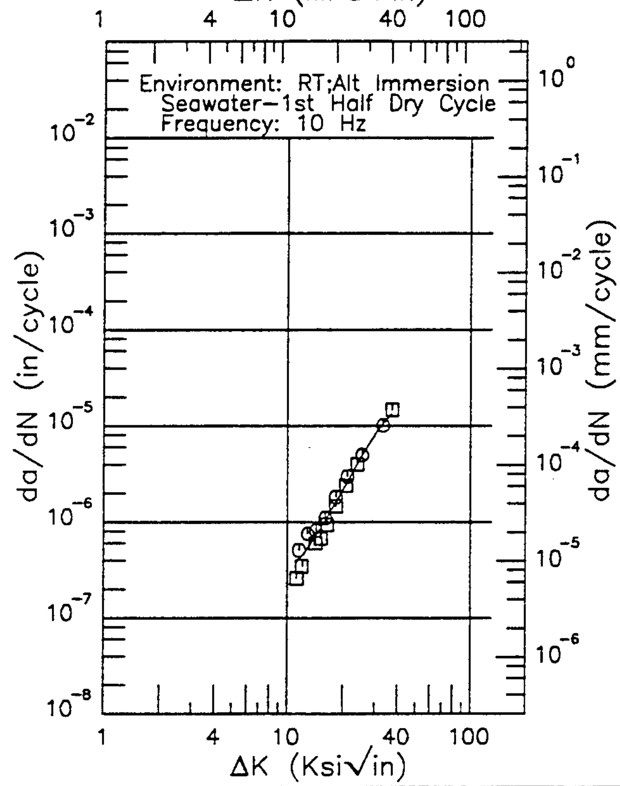
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.74 (min)	1.42
16.	2.51
20.	7.06
25.	11.7
30.	14.8
35.	18.0
40.	23.3
50.	50.6
51.60 (max)	59.3

RMS % Error 44.44

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(4 of 6)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.22 (min)	0.382
13.	0.543
16.	1.01
20.	2.17
25.	4.65
30.	8.12
35.	11.9
37.07 (max)	13.4

RMS % Error 17.96

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

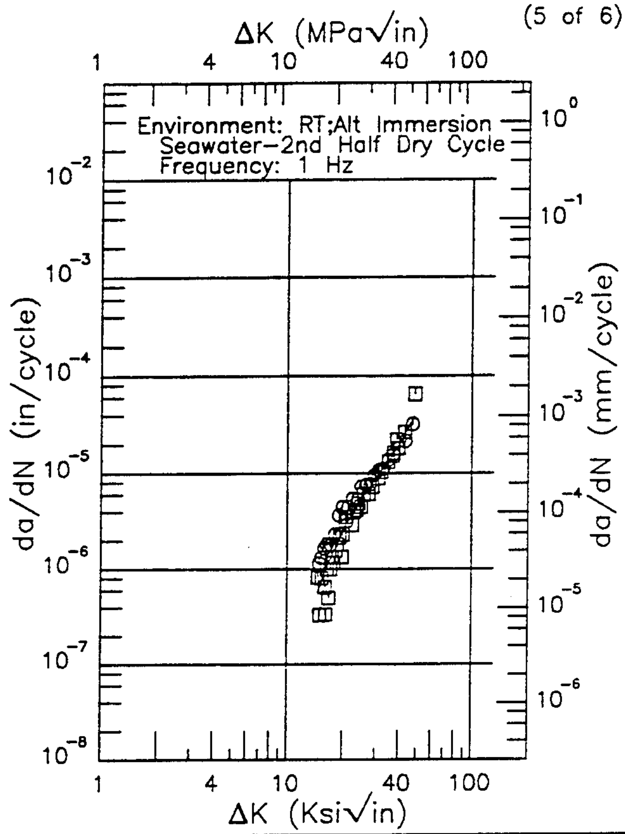
Figure 3.13.3.1.7 (Continued)

EF 300M

Condition/Ht: UTS=280–300KSI
Form: 3.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L–T
Stress Ratio: 0.

Yield Strength: 248 ksi
Ult. Strength: 295.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 in.
Ref: MA010

(5 of 6)



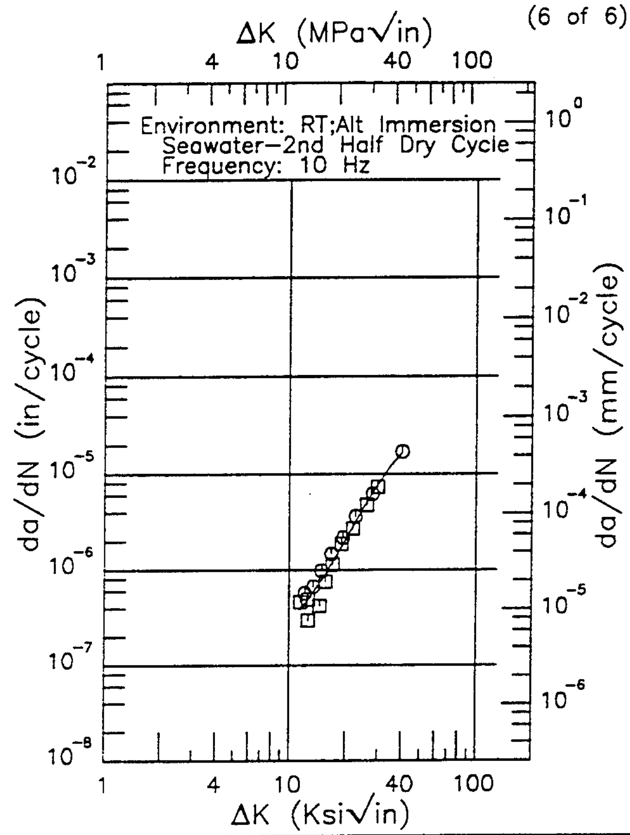
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.64 (min)	0.575
16.	0.955
20.	2.61
25.	5.44
30.	8.94
35.	13.5
40.	19.8
48.51 (max)	38.8

RMS % Error 35.95

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(6 of 6)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.50 (min)	0.386
13.	0.524
16.	0.972
20.	2.05
25.	4.41
30.	7.89
35.	12.1
40.	16.5
40.07 (max)	16.5

RMS % Error 20.15

Life Prediction Ratio Summary

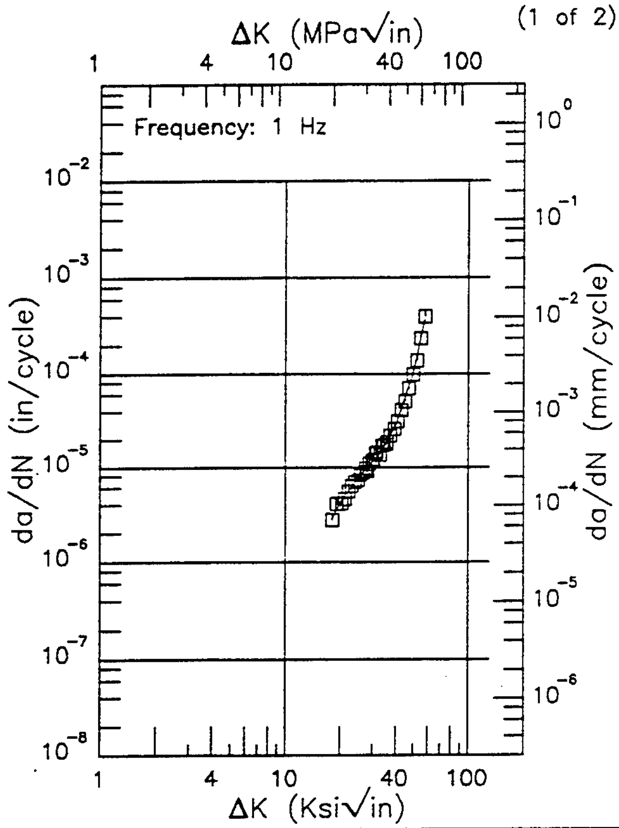
0. .5 .8 1.25 2.

Figure 3.13.3.1.7 (Concluded)

Condition/Ht: UTS=280–300KSI
Form: 3.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L–T
Stress Ratio: 0.
Environment: 3.5% NACL; RT

Yield Strength: 250 ksi
Ult. Strength: 298 ksi
Specimen Thk: 0.25 in.
Specimen Width: 4 in.
Ref: MA007

(1 of 2)



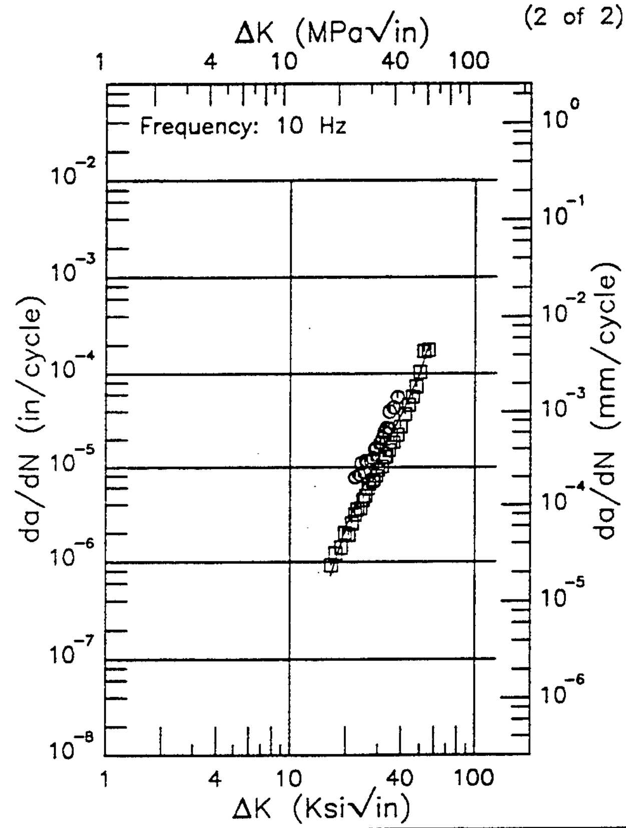
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.02 (min)	2.84
20.	4.20
25.	7.61
30.	11.4
35.	17.4
40.	28.7
50.	105.
57.63 (max)	367.

RMS % Error 6.38

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.55 (min)	0.723
20.	2.24
25.	6.17
30.	12.3
35.	21.5
40.	35.9
50.	100.
55.70 (max)	186.

RMS % Error 41.95

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

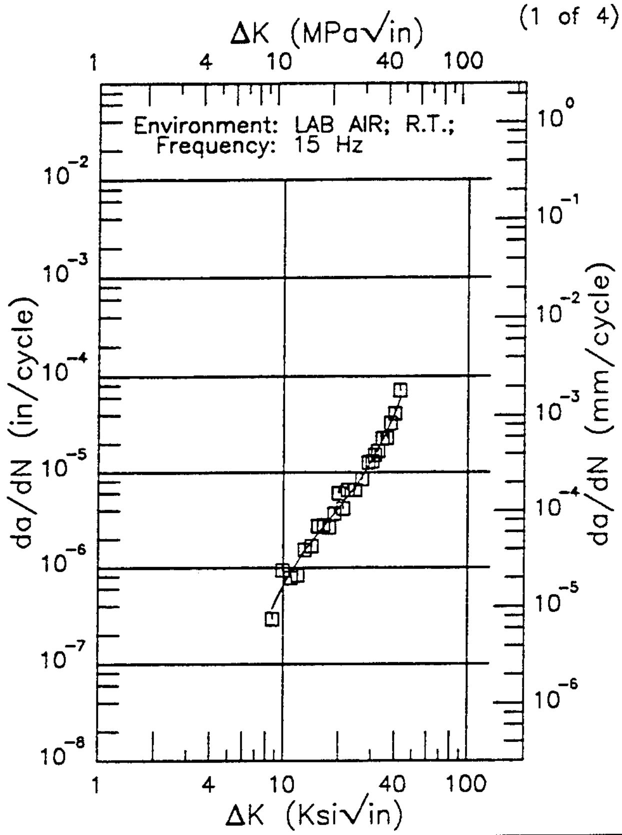
Figure 3.13.3.1.8

EF | 300M

Condition/Ht:
Form: 1.25 in. Forging
Specimen Type: WOL
Orientation: L-T
Stress Ratio: 0.02

Yield Strength: 239 – 246.5 ksi
Ult. Strength: 291 – 297 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: MA005

(1 of 4)



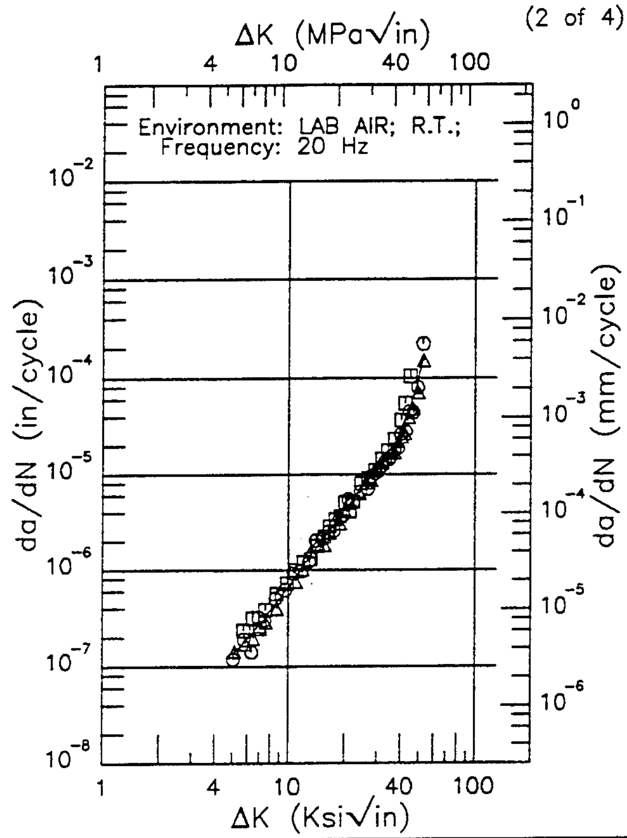
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.67 (min)	0.376
9.	0.439
10.	0.656
13.	1.48
16.	2.50
20.	4.24
25.	7.53
30.	13.2
35.	23.5
40.	42.7
42.62 (max)	58.9

RMS % Error 17.97

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.02 (min)	0.135
6.	0.193
7.	0.273
8.	0.378
9.	0.509
10.	0.671
13.	1.36
16.	2.38
20.	4.26
25.	7.32
30.	10.9
35.	15.7
40.	25.0
50.	105.
52.48 (max)	167.

RMS % Error 18.82

Life Prediction Ratio Summary

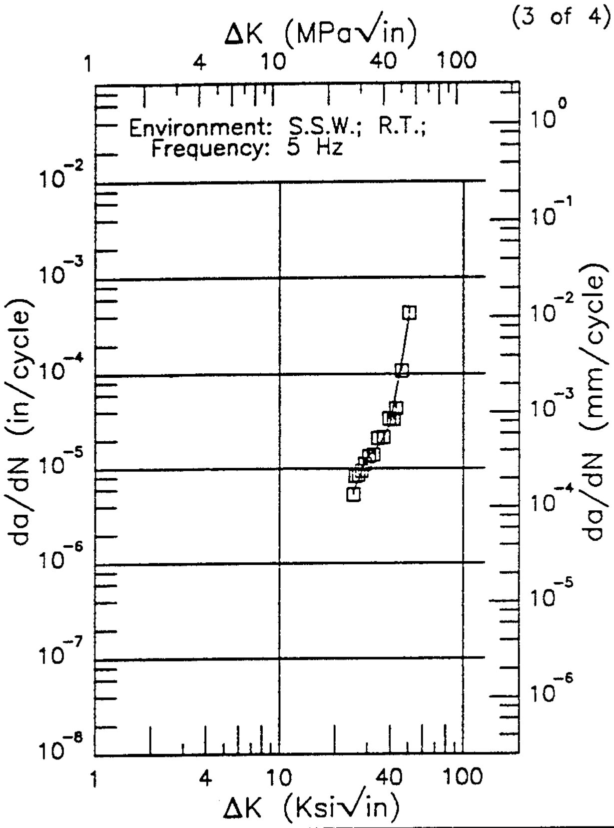
0. .5 .8 1.25 2.

Figure 3.13.3.1.9

Condition/Ht:
Form: 1.25 in. Forging
Specimen Type: WOL
Orientation: L-T
Stress Ratio: 0.02

Yield Strength: 239 – 246.5 ksi
Ult. Strength: 291 – 297 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: MA005

(3 of 4)



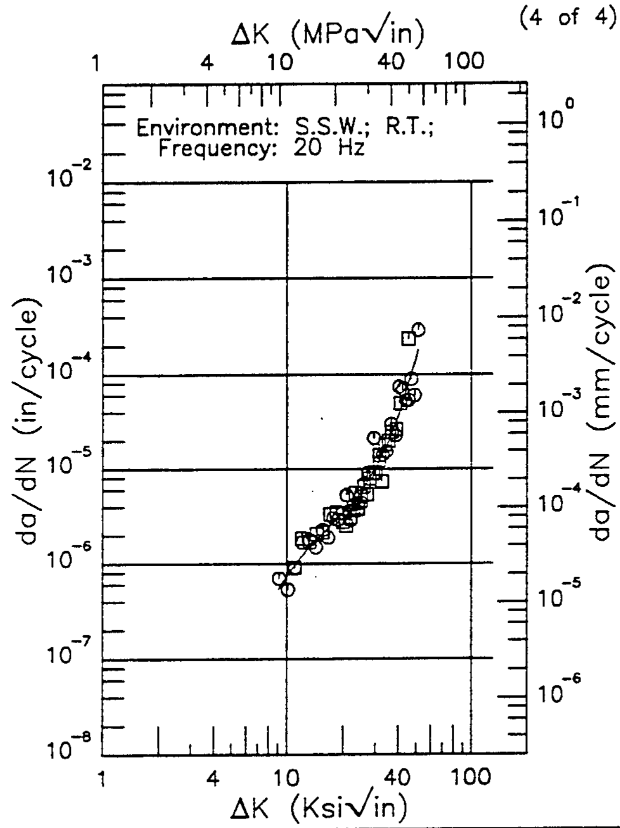
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
25.14 (min)	5.80
30.	13.0
35.	18.3
40.	30.6
50.	349.
50.39 (max)	400.

RMS % Error: 17.38

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(4 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.06 (min)	0.539
10.	0.745
13.	1.45
16.	2.19
20.	3.38
25.	5.69
30.	9.97
35.	18.4
40.	35.6
50.	150.
51.27 (max)	181.

RMS % Error: 39.55

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.13.3.1.9 (Concluded)

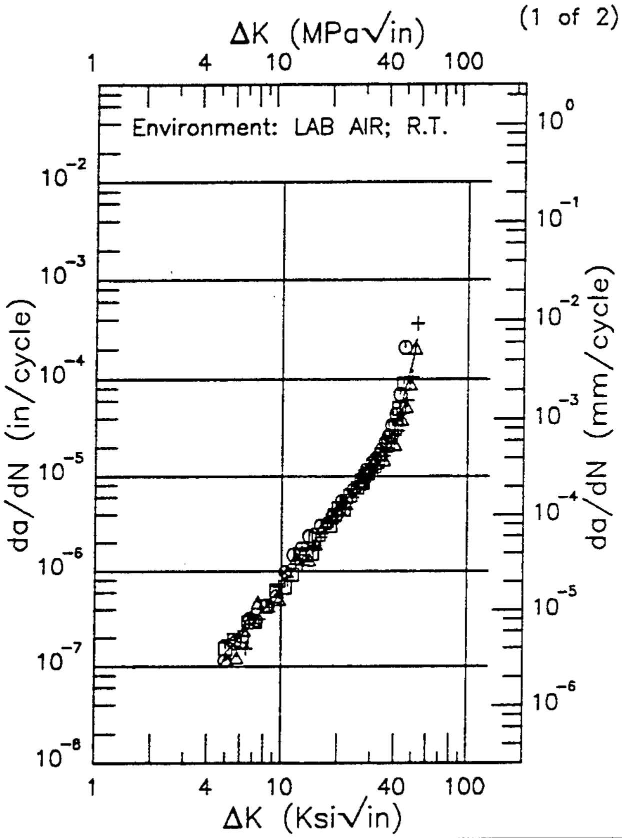
300M

E

Condition/Ht:
Form: 1.25 in. Forging
Specimen Type: WOL
Orientation: T-L
Stress Ratio: 0.02
Frequency: 0.1 – 20 Hz

Yield Strength: 240 – 246.5 ksi
Ult. Strength: 290.5 – 299 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: MA005

(1 of 2)



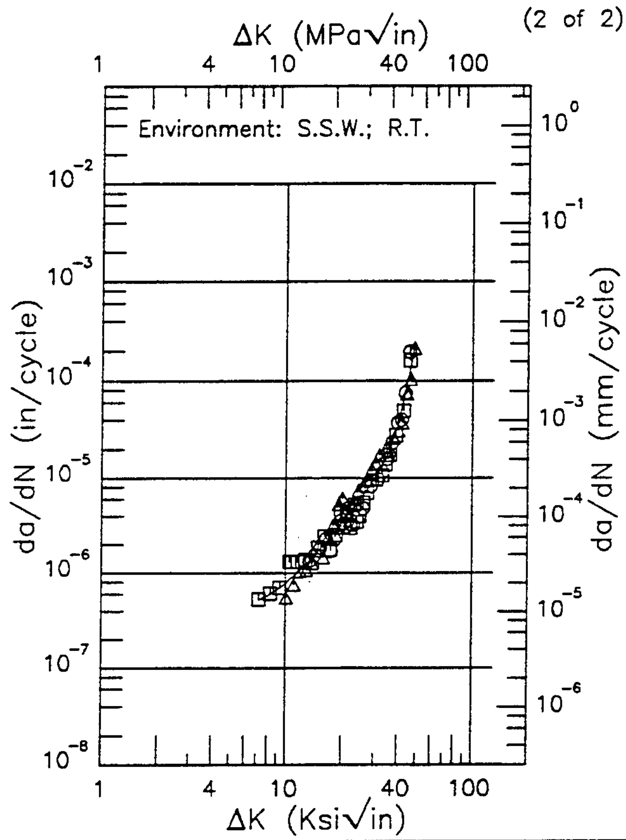
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.96 (min)	0.138
5.	0.140
6.	0.207
7.	0.294
8.	0.404
9.	0.540
10.	0.704
13.	1.39
16.	2.41
20.	4.35
25.	7.79
30.	12.4
35.	19.3
40.	33.1
50.	156.
52.52 (max)	256.

RMS % Error 22.54

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.19 (min)	0.521
8.	0.579
9.	0.670
10.	0.782
13.	1.26
16.	1.97
20.	3.36
25.	5.96
30.	9.70
35.	16.5
40.	34.4
48.66 (max)	222.

RMS % Error 24.08

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.13.3.1.10

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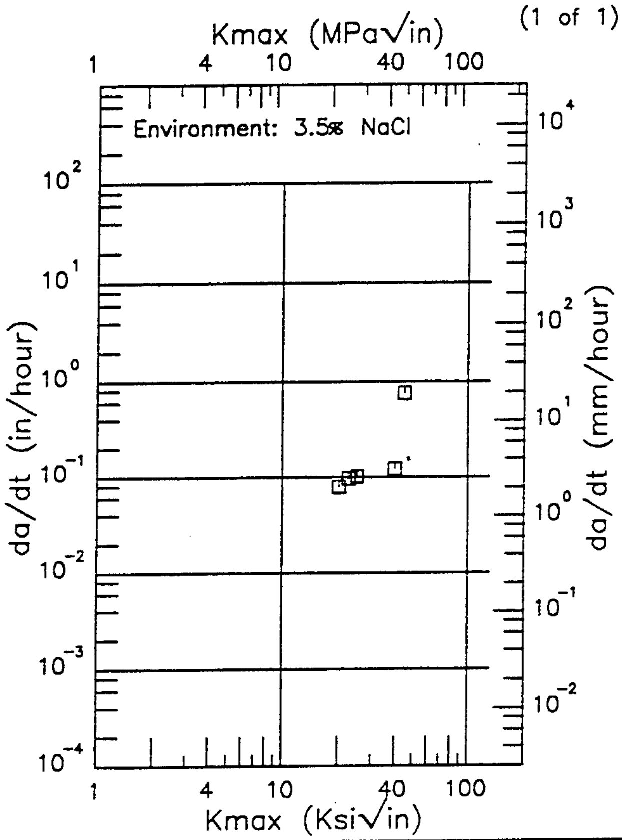
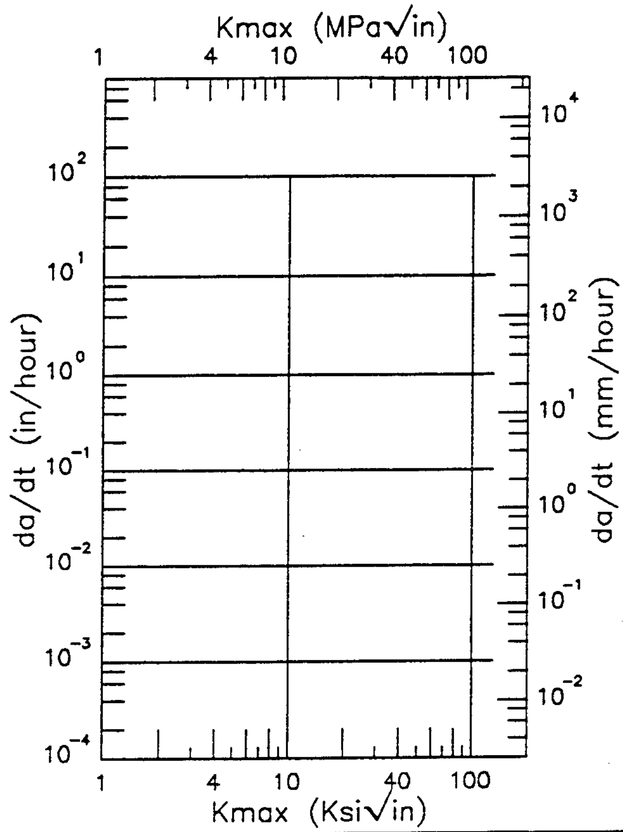
300M

Condition/Ht:	Specimen Thk:
Form:	Specimen Width:
Specimen Type: TDCB	Ao:
Orientation:	KIscc:
Yield Strength:	Ref: 78313
Ult. Strength:	

(1 of 1)





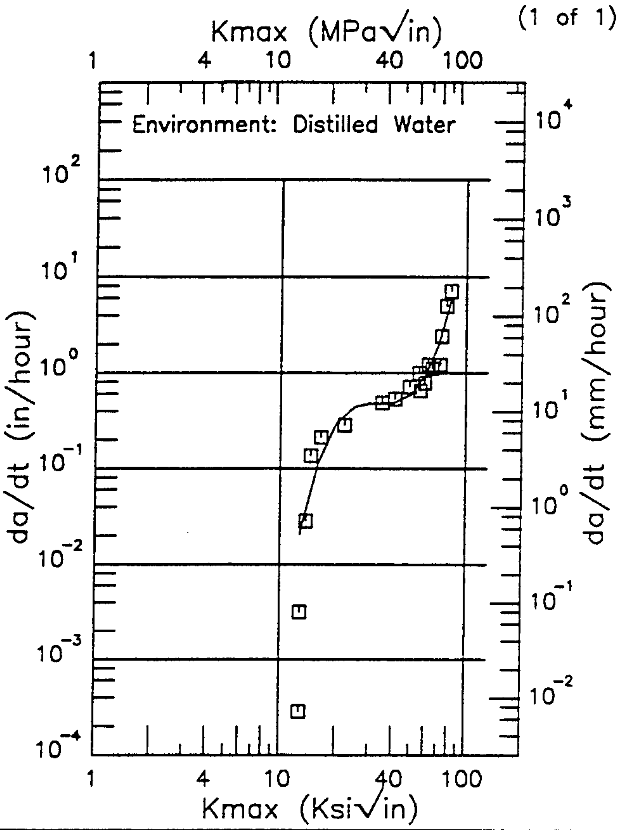
Kmax (Ksi√in)	da/dt (10^{-3}in/hour)	Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

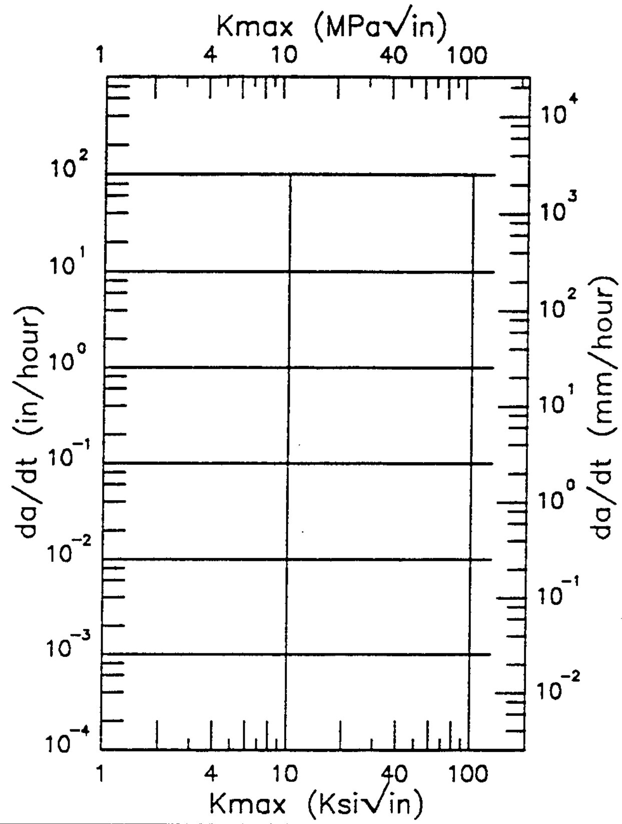
RMS % Error		RMS % Error	

Figure 3.13.3.2.1

Condition/Ht: 1600F OQ 575F 2+2HR
Form: 0.1 in. Sheet
Specimen Type: DCB
Orientation: T-L
Yield Strength: 245 ksi
Ult. Strength:

Specimen Thk: 0.1 in.
Specimen Width:
A_O:
K_{Iscc}:
Ref: 85545





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
12.80 (min)	20.6
13.	23.9
16.	115.
20.	297.
25.	442.
30.	480.
35.	481.
40.	489.
50.	595.
60.	942.
70.	1897.
80.	4671.
82.00 (max)	5710.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error 52.15

RMS % Error

Figure 3.13.3.2.2

TABLE 3.13.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 300M

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
Unspecified	P	R.T.	---	289	3.5% NaCl	CANT*	1.5	0.5	---	0.3	89	12	---	1971	84351
Unspecified	P	R.T.	L-S	236	3.5% NaCl	NB	1.5	0.48	0.48	---	76	13	---	1967	74302
Unspecified	F	R.T.	S-T	240.2	Sim. Sea Water	BWOL	3.091	1.242	1.25	1.35	---	15.4	86400	1977	MA005
						BWOL	3.088	1.247	1.25	1.35	---	15.4	86400	1977	MA005
						BWOL	3.101	1.249	1.25	1.36	---	15.7	86400	1977	MA005
						BWOL	3.091	1.251	1.25	1.37	---	15.6	86400	1977	MA005
1500°F 0.5hr OQ; 400°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	202	3.5% NaCl	CANT*	1.5	0.5	0.56	---	36	12	---	1970	78305
1500°F 0.5hr OQ; 550°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	232	3.5% NaCl	CANT*	1.5	0.5	0.56	---	42	15	---	1970	78305
1500°F 0.5hr OQ; 400°F 2+2 hr (Fine Grained Structure)	P	R.T.	---	245	3.5% NaCl	CANT*	1.5	0.5	0.56	---	60	12	---	1970	78305
1500°F 0.5hr OQ; 550°F 2+2 hr (Fine Grained Structure)	P	R.T.	---	247	3.5% NaCl	CANT*	1.5	0.5	0.56	---	56	15	---	1970	78305

TABLE 3.13.3.3 (CONTINUED)

K_{Iscc} SUMMARY FOR ALLOY STEEL 300M

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
1550°F 0.5hr OQ 400°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	240	3.5% NaCl	CANT*	1.5	0.5	0.56	---	53	15	---	1970	78305
1550°F 0.5hr OQ 400°F 2+2 hr (Fine Grained Structure)	P	R.T.	---	241	3.5% NaCl	CANT*	1.5	0.5	0.56	---	53	15	---	1970	78305
1550°F 0.5hr OQ 550°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	246	3.5% NaCl	CANT*	1.5	0.5	0.56	---	60	15	---	1970	78305
1550°F 0.5hr OQ 550°F 2+2 hr (Fine Grained Structure)	P	R.T.	---	248	3.5% NaCl	CANT*	1.5	0.5	0.56	---	64	15	---	1970	78305
1600°F 0.5hr OQ 400°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	220	3.5% NaCl	CANT*	1.5	0.5	0.56	---	67	12	---	1970	78305
1600°F 0.5hr OQ 550°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	232	3.5% NaCl	CANT*	1.5	0.5	0.56	---	65	12	---	1970	78305

TABLE 3.13.3.3 (CONTINUED

K_{Iscc} SUMMARY FOR ALLOY STEEL 300M

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
1600°F 0.5hr OQ 550°F 2+2 hr (Fine Grained Structure)	P	R.T.	---	245	3.5% NaCl	CANT*	1.5	0.5	0.56	---	65	12	---	1970	78305
1650°F 1525F OQ 600°F 2+2 hr	F	R.T.	---	247	Air-90% RH	PTSC	1.5	0.48	5	0.14	73.9	71	---	1965	74718
1650°F 1600°F 1hr OQ 600°F 1+1 hr	F	R.T.	L-S	251.5	3.5% NaCl	CANT	1.5	0.48	4	---	63.5	19.6	---	1965	74718
1700°F 1.5hr AC 1600°F 1.5hr OQ 600°F 2+2hr	F	R.T.	L-T	238	F.C.S.	DCB	2	1	3	---	150	<21	---	1976	RI006
						DCB	2	1	3	---	150	<29	---	1976	RI006
						DCB	2	1	3	---	150	<30	---	1976	RI006
					S.C.S.	DCB	2	1	3	---	150	39	116760	1976	RI006
						DCB	2	1	3	---	150	39	116760	1976	RI006
						DCB	2	1	3	---	150	36	116760	1976	RI006
					S.T.W.	DCB	2	1	3	---	150	<25	---	1976	RI006
						DCB	2	1	3	---	150	<21	---	1976	RI006
			S-L	---	S.T.W.	DCB	2	1	3	---	150	<25⁺	---	1976	RI006
						DCB	2	1	3	---	150	<25⁺	---	1976	RI006
						DCB	2	1	3	---	150	16⁺	76200	1976	RI006
						DCB	2	1	3	---	150	15⁺	76200	1976	RI006

TABLE 3.13.3.3 (CONCLUDED)

K_{Iscc} SUMMARY FOR ALLOY STEEL 300M

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
1710°F+1610°F AC 1600°F 1.5hr OQ 600°F 2+2hr	B	R.T.	L-T	250	3.5% NaCl	NB	1	0.5	0.63	---	58.9	18	---	1971	84087
1710°F+1610°F 610°F	B	R.T.	L-T	250	3.5% NaCl	NB	1	0.5	0.63	---	59.8	17.6	---	1971	84087
						NB	1	0.5	0.63	---	54.7	16.7	---	1971	84087
			T-L	250	3.5% NaCl	CT	---	0.5	0.63	---	61.2	18.9	---	1971	84087
						CT	---	0.5	0.63	---	51.5	16.3	---	1971	84087
						CT	---	0.5	0.63	---	55.5	18	---	1971	84087
						CT	---	0.5	0.63	---	55.9	17.3	---	1971	84087

+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.14.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 300M (AM) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1650F 1HR AC 1550F 1HR OQ -320F 0.5HR 600F 2+2HR AC	46.5	3.8	3	---	---	---	---	---	---

TABLE 3.14.2.1

ALLOY STEEL 300M (AM) K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1650F 1 HR AC 1650F 1 HR OQ -320F 0.5 HR 600F 2+2 HR AC	Forging	4.00	R.T.	L-T	262.0	1.800	0.900	NB	---	0.07	43.60	46.5	3.8	1968	73300
		4.00			262.0	1.800	0.900	NB	---	0.07	45.10			1968	73300
		4.00			262.0	1.800	0.900	NB	---	0.09	50.80			1968	73300

TABLE 3.15.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 300M (VAR) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1650F 1HR AC 1550F 1HR OQ -320F 0.5HR 600F 2+2HR AC	52.2	1.3	4	---	---	---	---	---	---

TABLE 3.15.2.1

ALLOY STEEL 300M (VAR) K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1650F 1 HR AC 1550F 1 HR OQ -320F 0.5 HR 600F 2+2 HR AC	Forging	4.50	R.T.	L-T	259.0	1.800	0.900	NB	---	0.10	51.10	52.2	1.3	1968	73300
		4.50			259.0	1.800	0.900	NB	---	0.11	53.60			1968	73300
		4.50			259.0	1.800	0.900	NB	---	0.11	53.00			1968	73300
		4.50			259.0	1.800	0.900	NB	---	0.10	51.20			1968	73300

TABLE 3.16.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 300 (VM) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	1500F OQ 400F 2+2HR	48	17.	2	---	---	---	---	---	---
	1500F OQ 550F 2+2HR	49.5	10.6	2	---	---	---	---	---	---
	1550F OQ 550F 2+2HR	62.5	3.5	2	---	---	---	---	---	---
Billet	1700F AC 1600F 1HR OQ 550F 2+2HR	---	---	---	55.3	0.3	3	---	---	---
	1700F AC 1600F 1HR SQ 400F AC 550F 2+2HR	---	---	---	58.	3.4	3	---	---	---
	1700F AC 1600F 1HR SQ 975F OQ 575F 2+2HR	---	---	---	58.6	2.2	3	---	---	---

TABLE 3.16.2.1

ALLOY STEEL 300M(VM) K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5*(K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1500F OQ 400F 2+2HR	Plate	0.56	R.T.	L-T	202.0	1.500	0.500	NB	---	0.08	36.00	48.0	17.0	1970	78305
		0.56			245.0	1.500	0.500	NB	---	0.15	60.00			1970	78305 (1)
1500F OQ 550F 2+2HR	Plate	0.56	R.T.	L-T	233.0	1.500	0.500	NB	---	0.08	42.00	49.5	10.6	1970	78305
		0.56			248.0	1.500	0.500	NB	---	0.13	57.00			1970	78305 (1)
1550F OQ 400F 2+2HR	Plate	0.56	R.T.	L-T	242.0	1.500	0.500	NB	---	0.12	53.00	---	---	1970	78305
1550F OQ 550F 2+2HR	Plate	0.56	R.T.	L-T	248.0	1.500	0.500	NB	---	0.15	60.00	62.5	3.5	1970	78305
		0.56			248.0	1.500	0.500	NB	---	0.17	65.00			1970	78305 (1)
1600F OQ 400F 2+2HR	Plate	0.56	R.T.	L-T	220.0	1.500	0.500	NB	---	0.22	66.00	---	---	1970	78305
1600F OQ 550F 2+2HR	Plate	0.56	R.T.	L-T	233.0	1.500	0.500	NB	---	0.20	66.00	---	---	1970	78305
1700F AC 1600F 1HR OQ 550F 2+2HR	Billet	5.50	R.T.	T-L	239.0	2.500	1.000	CT	---	0.14	55.60	55.3	0.3	1972	84278
		5.50			239.0	2.500	1.000	CT	---	0.13	55.30			1972	84278
		5.50			239.0	2.500	1.000	CT	---	0.13	55.00			1972	84278
1700F AC 1600F 1HR SQ 400F AC 550F 2+2HR	Billet	5.50	R.T.	T-L	244.0	2.500	1.000	CT	---	0.14	56.70	58.0	3.4	1972	84278
		5.50			244.0	2.500	1.000	CT	---	0.16	61.80			1972	84278
		5.50			244.0	2.500	1.000	CT	---	0.13	55.40			1972	84278
1700F AC 1600F 1HR SQ 975F OQ 575 2+2HR	Billet	5.50	R.T.	T-L	242.0	2.500	1.000	CT	---	0.16	60.80	58.6	2.2	1972	84278
		5.50			242.0	2.500	1.000	CT	---	0.14	56.40			1972	84278
		5.50			242.0	2.500	1.000	CT	---	0.15	58.50			1972	84278

NOTES: (1) COLD ROLLED 50% WITH INTERMEDIATE ANNEALS AT 1275F TO GET FINE GRAIN SIZE

TABLE 3.17.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 4140 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$ Specimen Orientation L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	1600F 1HR 1550F 1HR OQ AT 150-175F 900F 1HR	---	---	---	72	18.8	2	---	---	---
Forged Bar	2010F 1 HR OQ 475F 1HR	52.1	7.4	2	---	---	---	---	---	---
	2190F 1 HR OQ 400F 1HR	81.1	13.2	2	---	---	---	---	---	---
	2190F 1 HR OQ 475F 1HR	66.1	2.7	2	---	---	---	---	---	---

TABLE 3.17.2.1

ALLOY STEEL 4140 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_Q/TYS)^2$ (in.)	K_{Ic}: K_Q (Ksi * $\sqrt{in.}$)	K_{Ic}: K_Q MEAN	K_{Ic}: STAN DEV	DATE	REFER
1600F 1 HR OQ 400F 1HR	Forged Bar	0.62	R.T.	L-T	210.0	2.000	0.600	CT	1.000	0.09	39.90	---	---	1973	87241 (1)
1600F 1 HR OQ 535F 1HR	Forged Bar	0.62	R.T.	L-T	230.0	2.000	0.600	CT	1.000	0.12	50.00	---	---	1973	87241 (1)
1600F 1 HR OQ 745F 1HR	Forged Bar	0.62	R.T.	L-T	220.0	2.000	0.600	CT	1.000	0.13	50.60	---	---	1973	87241 (1)
1600F 1HR 1550F 1HR OQ AT 150-175F 800F 1HR	Plate	1.00	-65	T-L	198.1	2.001	0.994	CT	1.034	0.10	41.30	40.1	1.7	1980	MR002
		1.00			198.1	2.003	0.994	CT	1.055	0.09	38.90			1980	MR002
1600F 1HR 1550F 1HR OQ AT 150-175F 800F 1HR	Plate	1.00	R.T.	T-L	175.0	2.003	0.994	CT	1.040	0.28	58.70	---	---	1980	MR002
1600F 1HR 1550F 1HR OQ AT 150-175F 800F 1HR	Plate	1.00	165	T-L	167.7	2.002	0.994	CT	1.045	0.44	71.10	68.6	3.5	1980	MR002
		1.00			167.7	2.000	0.990	CT	1.037	0.38	66.19			1980	MR002
1600F 1HR 1550F 1HR OQ AT 150-175F 900F 1HR	Plate	1.00	-65	T-L	176.3	2.003	0.994	CT	1.033	0.31	62.50	68.6	8.6	1980	MR002
		1.00			176.3	2.002	0.994	CT	1.022	0.44	74.69			1980	MR002
1600F 1HR 1550F 1HR OQ AT 150-175F 900F 1HR	Plate	1.00	R.T.	T-L	159.4	2.003	0.994	CT	1.024	0.71	85.30	---	---	1980	MR002
1600F 1HR 1550F 1HR OQ AT 150-175F 900F 1HR	Plate	1.00	165	T-L	156.0	2.000	0.990	CT	0.991	0.73	84.40	84.5	0.1	1980	MR002
		1.00			156.0	1.998	0.994	CT	1.015	0.73	84.60			1980	MR002
2010F 1 HR OQ 400F 1HR	Forged Bar	0.62	R.T.	L-T	200.0	2.000	0.600	CT	1.000	0.22	59.20	---	---	1973	87241 (1)
2010F 1 HR OQ 475F 1HR	Forged Bar	0.62	R.T.	L-T	210.0	2.000	0.600	CT	1.000	0.12	46.80	52.1	7.4	1973	87241 (1)
		0.62			210.0	2.000	0.600	CT	1.000	0.19	57.30			1973	87241 (1)
2190F 1 HR OQ 400F 1HR	Forged Bar	0.62	R.T.	L-T	200.0	2.000	0.600	CT	1.000	0.51	90.40	81.1	13.2	1973	87241 (1)
		0.62			200.0	2.000	0.600	CT	1.000	0.32	71.70			1973	87241 (1)
2190F 1 HR OQ 475F 1HR	Forged Bar	0.62	R.T.	L-T	210.0	2.000	0.600	CT	1.000	0.26	68.00	66.1	2.7	1973	87241 (1)
		0.62			210.0	2.000	0.600	CT	1.000	0.23	64.20			1973	87241 (1)
2190F 1 HR OQ 615F 1HR	Forged Bar	0.62	R.T.	L-T	205.0	2.000	0.600	CT	1.000	0.14	48.50	---	---	1973	87241 (1)
2190F 1 HR OQ 660F 1HR	Forged Bar	0.62	R.T.	L-T	202.0	2.000	0.600	CT	1.000	0.17	53.20	---	---	1973	87241 (1)

NOTES: (1) COMPOSITION (WT PERCENT) 0.40C, 0.94Mn, 0.008P, 0.012S, 0.28Si, 0.09Ni, 0.90Cr, 0.17Cu

TABLE 3.17.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 4140

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1550°F 1hr OQ; 1250°F 1hr AC	P	R.T.	---	105	Water Sat H_2S	CT	3.25	1	---	1	---	36	---	1972	84963
1550°F 1hr OQ; 100°F 1hr AC; 1125F 1hr AC	P	R.T.	---	147.5	Water Sat H_2S	CT	3.25	1	---	1	---	17.5	---	1972	84963
1700°F 1600°F OQ; 750°F 1+1 hr	P	R.T.	---	195	Dist. Water	CANT*	1	0.25	0.25	0.2	49.4	15	---	1965	63061
1700°F 1600°F OQ; 600°F 1+1 hr	P	R.T.	---	241	Dist. Water	CANT*	1	0.25	0.25	0.2	40.1	11	---	1965	63061

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.18.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 4330V

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
Quenched + Tempered at 500°F	P	R.T.	L-S	196	3.5% NaCl	NB	1.5	0.48	0.48	0.3	103	25	---	1971	84351

TABLE 3.19.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 4330V MOD AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} ($ksi\sqrt{in}$) Specimen Orientation L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	HEAT TREATED TO 46 RC HARDNESS	---	---	---	74.7	0.8	2	---	---	---
Forged Bar	1600F 1HR OQ 535F 1HR	96.7	3.8	2	---	---	---	---	---	---
Billet	1650F 1HR AC 1575F 1HR OQ 800F 2+2HR	86.4	7.6	9	---	---	---	---	---	---

TABLE 3.19.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 4330V (MOD) AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	BILLET	0.02	1-30			1.98	7.29	27.92	

TABLE 3.19.2.1

ALLOY STEEL 4330V MOD K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic}: K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic}: K_{Ic} MEAN	K_{Ic}: STAN DEV	DATE	REFER
---	Billet	2.20	-65	L-T	194.5	2.502	1.259	CT	1.155	0.14	45.30	44.8	0.7	1974	MA011
		2.20			194.5	2.507	1.260	CT	1.153	0.13	44.30			1974	MA011
---	Billet	2.20	R.T.	L-T	194.5	2.504	1.253	CT	1.164	0.43	80.70	---	---	1974	MA011
1600F 1 HR OQ 400F 1 HR	Forged Bar	0.62	R.T.	L-T	198.0	2.000	0.600	CT	1.000	0.49	88.00	---	---	1973	87241 (1)
1600F 1 HR OQ 535F 1 HR	Forged Bar	0.62	R.T.	L-T	202.0	2.000	0.600	CT	1.000	0.60	99.40	96.7	3.8	1973	87241 (1)
		0.62			202.0	2.000	0.600	CT	1.000	0.54	94.00			1973	87241 (1)
1650F 1 HR AC 1575F 1 HR OQ 525F 2+2 HR	Billet	6.00	R.T.	L-T	203.0	2.500	1.000	CT	1.400	0.34	77.50	81.6	2.3	1972	84277
		6.00			203.0	2.500	1.000	CT	1.400	0.48	84.20			1972	84277
		6.00			203.0	2.500	1.000	CT	1.400	0.38	81.60			1972	84277
		6.00			203.0	2.500	1.000	CT	1.400	0.45	81.20			1972	84277
		6.00			203.0	2.500	1.000	CT	1.400	0.46	82.20			1972	84277
		6.00			203.0	2.500	1.000	CT	1.400	0.39	82.80			1972	84277
1650F 1 HR AC 1575F 1 HR OQ 800F 2+2 HR	Billet	6.00	R.T.	L-T	191.0	2.500	1.000	CT	1.400	0.68	99.70	96.1	3.2	1972	84277
		6.00			191.0	2.500	1.000	CT	1.400	0.60	93.80			1972	84277
		6.00			191.0	2.500	1.000	CT	1.400	0.61	94.70			1972	84277
HEAT TREATED TO 46 RC HARDNESS	Plate	0.62	R.T.	T-L	193.0	1.502	0.750	NB	0.762	0.38	75.20	74.6	0.8	1971	84029
		0.62			193.0	1.498	0.750	NB	0.758	0.37	74.10			1971	84029

NOTES: (1) COMPOSITION (WT PERCENT) 0.28C, 1.02Mn, 0.009P, 0.005S, 0.28Si, 1.80Ni, 0.85Cr, 0.07V, 0.01Cu

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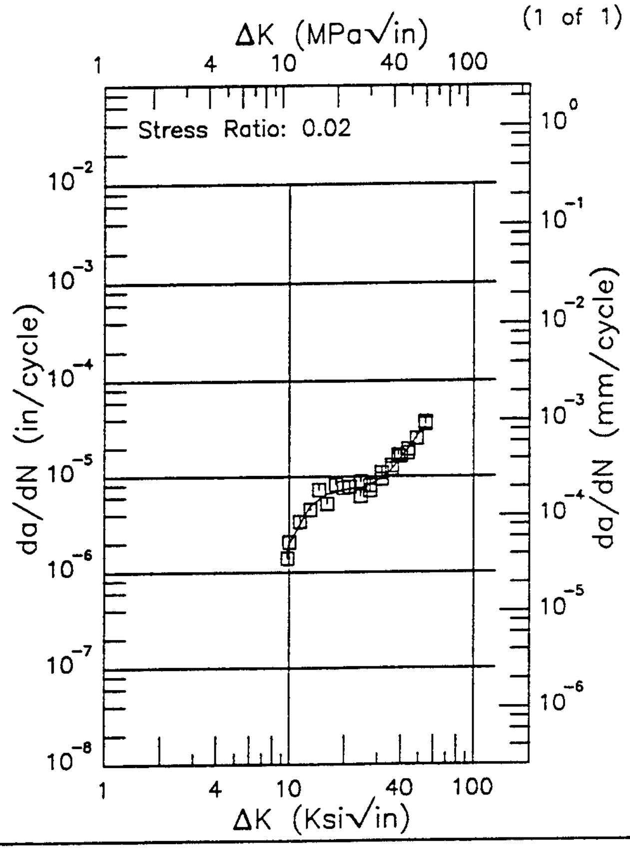
R

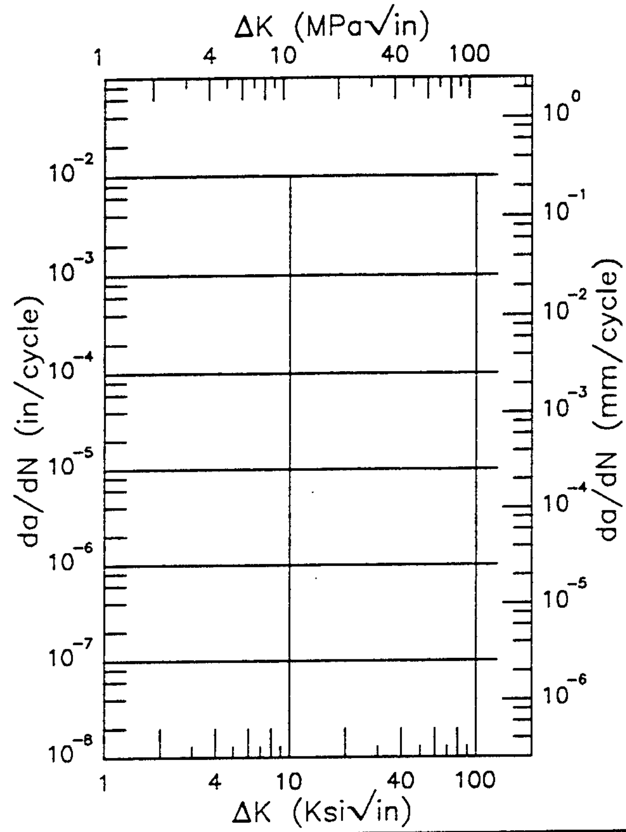
4330V (MOD)

Condition/Ht:
Form: 2.2 in. Billet
Specimen Type: WOL
Orientation: L–T
Frequency: 1 – 30 Hz
Environment: LAB AIR; RT

Yield Strength: 194.5 ksi
Ult. Strength: 231 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: MA011

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.72 (min)	1.72
10.	1.98
13.	4.82
16.	6.53
20.	7.29
25.	7.74
30.	8.89
35.	11.5
40.	15.7
50.	27.9
54.34 (max)	33.9

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
12.19	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.19.3.1

TABLE 3.20.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 4340 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} ($ksi\sqrt{in}$)								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	1550F OQ TEMPERED 500F	45.3	2.9	4	---	---	---	---	---	---
	1550F OQ TEMPERED 800F	76.6	4.6	2	---	---	---	---	---	---
	1600F 1HR 1525F 2.5HR OQ AT 150-175F 900F 1HR	---	---	---	88.2	1.5	2	---	---	---
	HEAT TREATED TO 51 RC HARDNESS	---	---	---	51.7	1.3	2	---	---	---
Forged Bar	1600F 1HR OQ 535F 1HR	60.9	0.8	2	---	---	---	---	---	---
	2190F 1HR FC TO 1600F HOLD 0.5HR 400F 1HR	76.8	0.1	2	---	---	---	---	---	---
	2190F 1HR FC TO 1600F HOLD 0.5HR 535F 1HR	60.1	3.2	2	---	---	---	---	---	---
	2190F 1HR FC TO 1600F HOLD 0.5HR 660F 1HR	60.8	0.8	2	---	---	---	---	---	---
Billet	1650F 1HR AC 1525F 1HR OQ 800F 2HR	76.3	3.6	6	---	---	---	---	---	---

TABLE 3.20.1.2.1

**FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
4340 AT ROOM TEMPERATURE**

ORIENTATION: L-T **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
MARTEMPERED	PLATE	0.02				0.48	3.43	24.63	154.57

TABLE 3.20.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
4340 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=180-200KSI	BAR	0.05	3				2.94	17.78	
		0.5	3			0.71	3.78		

TABLE 3.20.1.2.3

**FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
4340 AT ROOM TEMPERATURE**

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
MARTEMPERED	PLATE	0.02				0.52	3.06	22.96	115.4
UTS=150KSI	FORGING	0.1	30		0.02	0.28	2.44		
	UNSPECIFIED	-0.1	2-5			0.44			
UTS=160KSI	ROUND BAR	0.1	7				2.47		
		0.5	7		0.09				
		0.5	7			0.61	3.6		
UTS=160-180KSI	BAR	0.1	20				2.69	30.66	
		0.5	20		0.09	0.64	3.9	34.11	
		0.8	20			0.68	4.16		
UTS=180KSI	FORGING	0.1	20-30		0.02	0.35	2.52		
		0.5	30		0.08	0.58	3.4		
	ROUND BAR	0.1	20				2.89	23.41	
		0.1	30			0.42			
		0.5	7			0.65			
		0.5	7		0.09				

TABLE 3.20.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
4340 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: Argon**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi*√*in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
450F TEMPER	UNSPECIFIED		0.4				3.16		
750F TEMPER	UNSPECIFIED		0.4				2.92	20.75	

TABLE 3.20.1.2.5

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
4340 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
450F TEMPER	UNSPECIFIED		0.4				274.31	443.28	
750F TEMPER	UNSPECIFIED		0.04				451.66		
			0.2				105.97	171.95	
			0.4				65.04	143.63	

TABLE 3.20.1.2.6

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 4340 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
UTS=180-200KSI	PLATE	0.	10				2.68		
		0.5	10					45.14	

TABLE 3.20.2.1

ALLOY STEEL 4340 K_{Ic}

CONDITION	PRODUCT		TEST TEMP (F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1550F OQ TEMPERED 500F	Plate	1.00	R.T.	L-T	238.0	0.160	0.800	CT	0.800	---	48.00	45.3	2.9	1971	86582
		1.00			238.0	0.160	0.800	CT	0.800	---	45.80			1971	86582
		1.00			238.0	0.160	0.800	CT	0.800	---	46.00			1971	86582
		1.00			238.0	0.160	0.800	CT	0.800	0.09	41.20			1971	86582
1550F OQ TEMPERED 800F	Plate	1.00	R.T.	L-T	206.0	0.160	0.800	CT	0.800	---	79.80	76.6	4.6	1971	86582
		1.00			206.0	0.160	0.800	CT	0.800	0.37	73.30			1971	86582
1600F 1 HR OQ 400F 1 HR	Forged Bar	0.62	R.T.	L-T	195.0	2.000	0.600	CT	1.000	0.23	59.50	---	---	1973	87241 (1)
1600F 1 HR OQ 535F 1 HR	Forged Bar	0.62	R.T.	L-T	218.0	2.000	0.600	CT	1.000	0.19	61.40	60.9	0.8	1973	87241 (1)
		0.62			218.0	2.000	0.600	CT	1.000	0.19	60.30			1973	87241 (1)
1600F 1 HR OQ 660F 1 HR	Forged Bar	0.62	R.T.	L-T	217.0	2.000	0.600	CT	1.000	0.34	79.80	---	---	1973	87241 (1)
1600F 1 HR OQ 745F 1 HR	Forged Bar	0.62	R.T.	L-T	210.0	2.000	0.600	CT	1.000	0.47	91.20	---	---	1973	87241 (1)
1600F 1HR 1525F 2.5 HR OQ AT 150-175F 900F 1 HR	Plate	1.00	-65	T-L	190.3	1.998	1.004	CT	1.022	0.54	89.19	90.1	1.3	1980	MR002
		1.00			190.3	1.997	1.004	CT	1.026	0.57	91.00			1980	MR002
1600F 1HR 1525F 2.5 HR OQ AT 150-175F 900F 1 HR	Plate	1.00	R.T.	T-L	179.4	2.000	1.030	CT	1.022	0.61	89.30	88.2	1.5	1980	MR002
		1.00			179.4	1.997	1.005	CT	1.027	0.59	87.19			1980	MR002
1600F 1HR 1525F 2.5 HR OQ AT 150-175F 900F 1 HR	Plate	1.00	165	T-L	171.1	1.999	0.994	CT	1.029	0.74	93.60	87.1	9.3	1980	MR002
		1.00			171.1	2.010	1.030	CT	0.990	0.55	80.50			1980	MR002

NOTES: (1) COMPOSITION (WT PERCENT) 0.40C, 0.80Mn, 0.010S. 0.24Si, 1.65Ni, 0.72Cr, 0.24Mo, 0.19Cu

TABLE 3.20.2.1 (CONCLUDED)

ALLOY STEEL 4340 K_{Ic}

CONDITION	PRODUCT		TEST TEMP (F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_Q (Ksi * $\sqrt{in.}$)	K_Q MEAN	STAN DEV		
1650F 1 HR AC 1525F 1 HR OQ 800F 2 HR	Billet	10.00	R.T.	L-T	197.0	2.500	1.000	CT	1.400	0.37	75.80	76.3	3.6	1972	84277
		10.00			197.0	2.500	1.000	CT	1.400	0.38	76.50			1972	84277
		10.00			197.0	2.500	1.000	CT	1.400	0.41	79.70			1972	84277
		10.00			211.0	2.500	1.000	CT	1.400	0.30	73.00			1972	84277
		10.00			211.0	2.500	1.000	CT	1.400	0.37	81.10			1972	84277
		10.00			211.0	2.500	1.000	CT	1.400	0.29	71.90			1972	84277
2190F 1HR FC TO 1600F HOLD 0.5HR 400F 1HR	Forged Bar	0.62	R.T.	L-T	195.0	2.000	0.600	CT	1.000	0.39	76.70	76.8	0.1	1973	87241 (1)
		0.62			195.0	2.000	0.600	CT	1.000	0.39	76.90			1973	87241 (1)
2190F 1HR FC TO 1600F HOLD 0.5HR 535F 1HR	Forged Bar	0.62	R.T.	L-T	202.0	2.000	0.600	CT	1.000	0.20	57.80	60.1	3.2	1973	87241 (1)
		0.62			202.0	2.000	0.600	CT	1.000	0.24	62.30			1973	87241 (1)
2190F 1HR FC TO 1600F HOLD 0.5HR 660F 1HR	Forged Bar	0.62	R.T.	L-T	200.0	2.000	0.600	CT	1.000	0.24	61.40	60.8	0.8	1973	87241 (1)
		0.62			200.0	2.000	0.600	CT	1.000	0.23	60.20			1973	87241 (1)
2190F 1HR OQ 475F 1HR	Forged Bar	0.62	R.T.	L-T	200.0	2.000	0.600	CT	1.000	0.42	82.40	---	---	1973	87241 (1)
2190F 1HR OQ 535F 1HR	Forged Bar	0.62	R.T.	L-T	202.0	2.000	0.600	CT	1.000	0.24	62.80	---	---	1973	87241 (1)
HEAT TREATED TO 51 RC HARDNESS	Plate	0.62	R.T.	T-L	220.0	0.999	0.499	NB	0.540	0.14	52.60	51.7	1.3	1971	84029
		0.62			220.0	0.998	0.498	NB	0.534	0.13	50.80			1971	84029
UTS = 180 KSI	Round Bar	4.50	R.T.	L-T	192.9	2.007	0.992	CT	0.933	0.77	107.20	---	---	1979	DA001

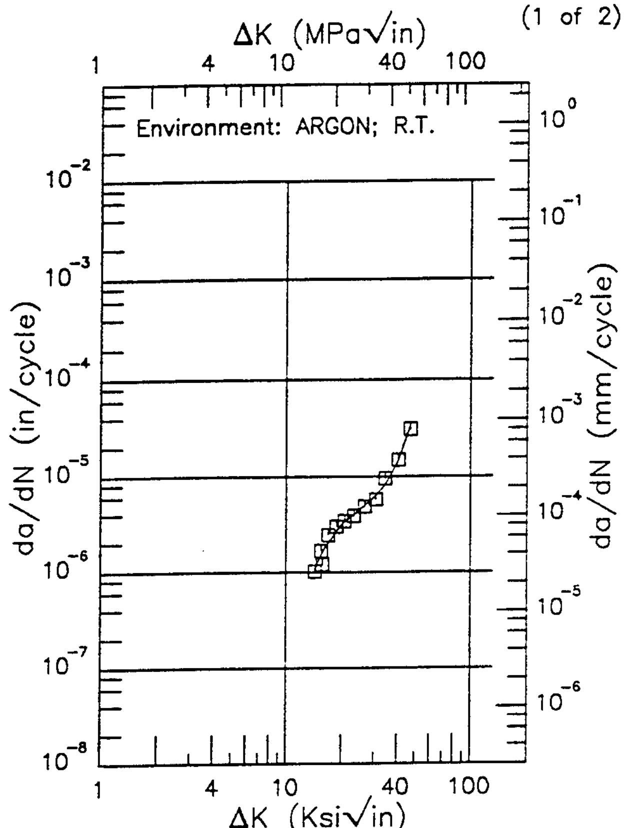
NOTES: (1) COMPOSITION (WT PERCENT) 0.40C, 0.80Mn, 0.010S. 0.24Si, 1.65Ni, 0.72Cr, 0.24Mo, 0.19Cu

E

4340

Condition/Ht: 450F TEMPER	
Form:	Yield Strength:
Specimen Type:	Ult. Strength:
Orientation:	Specimen Thk:
Stress Ratio:	Specimen Width:
Frequency: 0.4 Hz	Ref: 89311

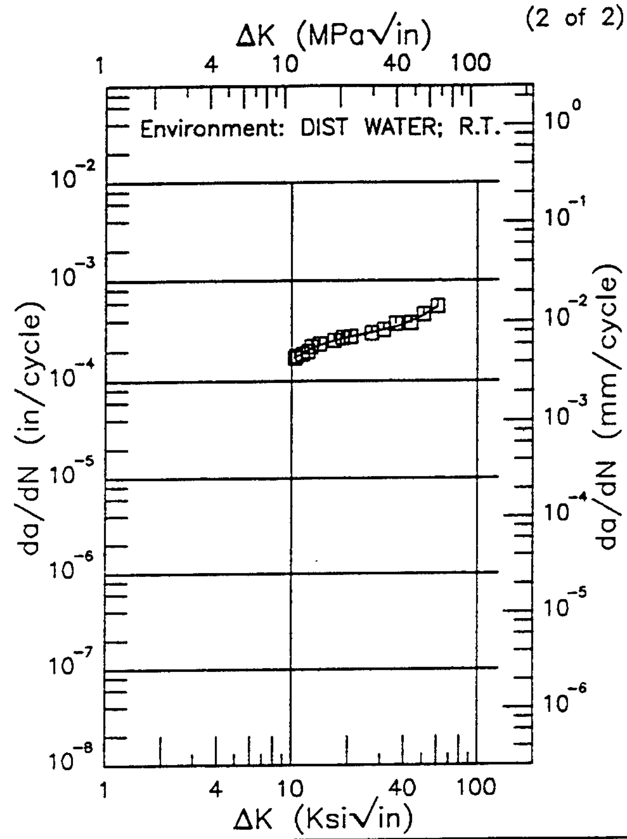
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.27 (min)	1.06
16.	1.73
20.	3.16
25.	4.53
30.	6.08
35.	8.71
40.	13.9
47.16 (max)	32.6

RMS % Error	Life Prediction Ratio Summary
11.47	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.39 (min)	174.
13.	216.
16.	247.
20.	274.
25.	298.
30.	320.
35.	344.
40.	372.
50.	443.
60.	542.
60.89 (max)	553.

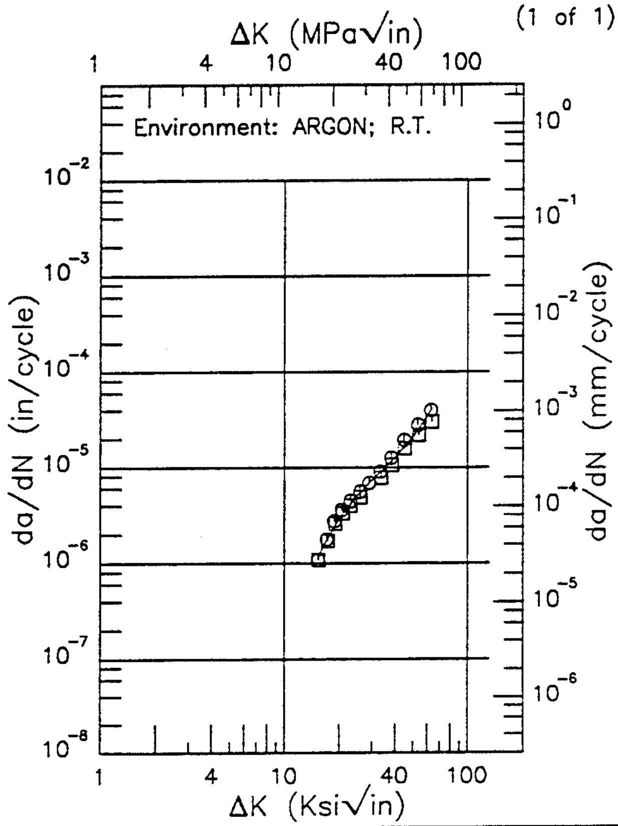
RMS % Error	Life Prediction Ratio Summary
2.83	0. .5 .8 1.25 2.

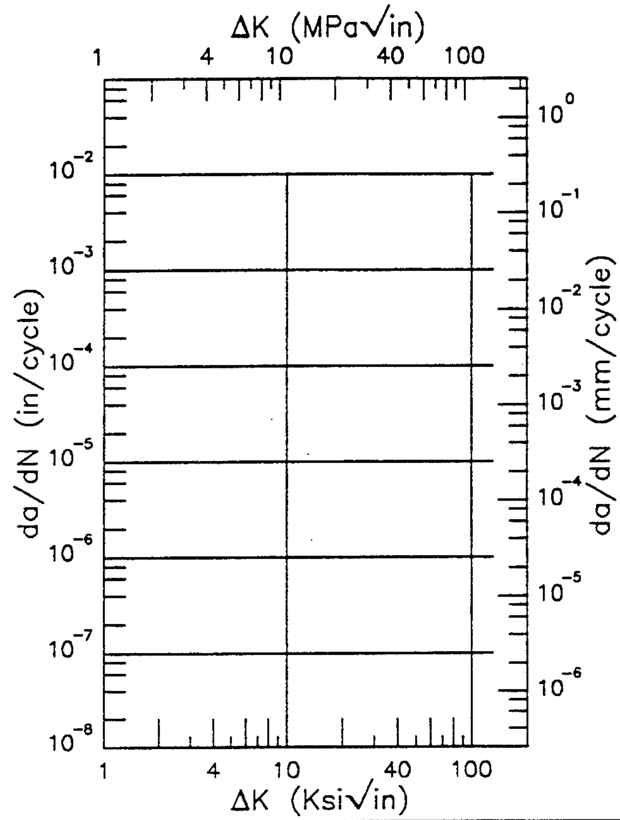
Figure 3.20.3.1.1

Condition/Ht: 750F TEMPER
Form:
Specimen Type:
Orientation:
Stress Ratio:
Frequency: 0.4 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 89311

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.20 (min)	1.14
16.	1.40
20.	2.92
25.	5.08
30.	7.35
35.	9.82
40.	12.7
50.	20.8
60.	34.4
63.54 (max)	41.5

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
10.96	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.20.3.1.2

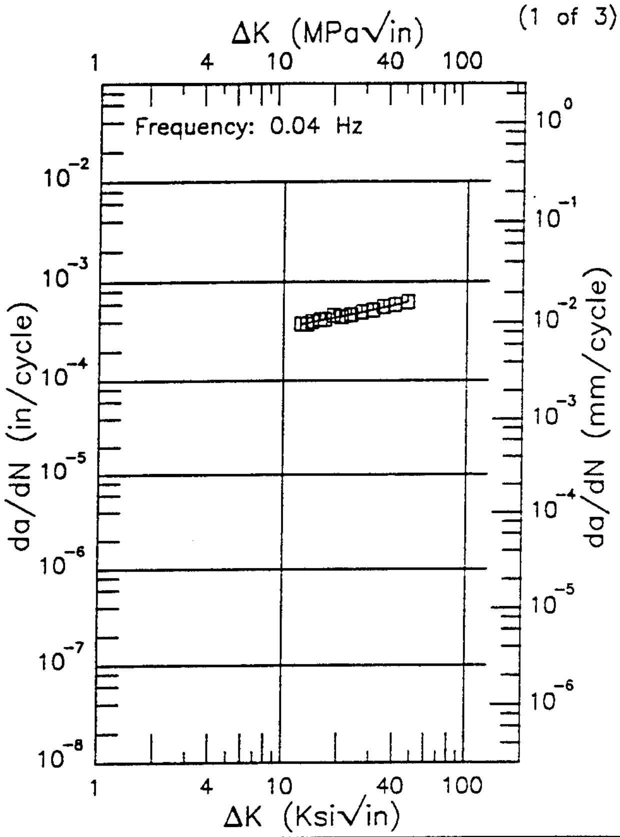
4340

F

Condition/Ht: 750F TEMPER
Form:
Specimen Type:
Orientation:
Stress Ratio:
Environment: DIST WATER; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 89311

(1 of 3)



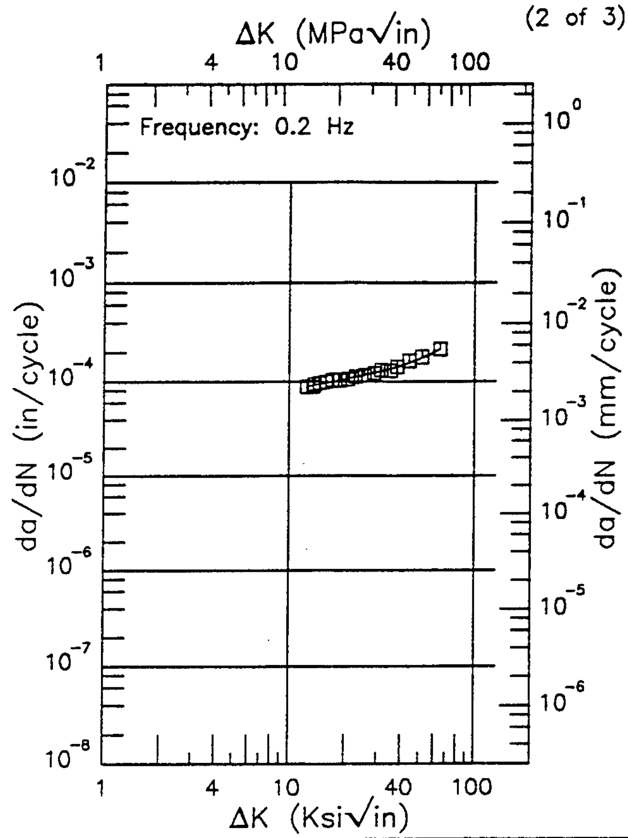
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.35 (min)	374.
13.	383.
16.	416.
20.	452.
25.	489.
30.	522.
35.	555.
40.	587.
47.13 (max)	633.

RMS % Error: 1.75

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.41 (min)	89.0
13.	90.6
16.	97.8
20.	106.
25.	116.
30.	126.
35.	136.
40.	147.
50.	172.
60.	201.
64.55 (max)	216.

RMS % Error: 2.31

Life Prediction Ratio Summary

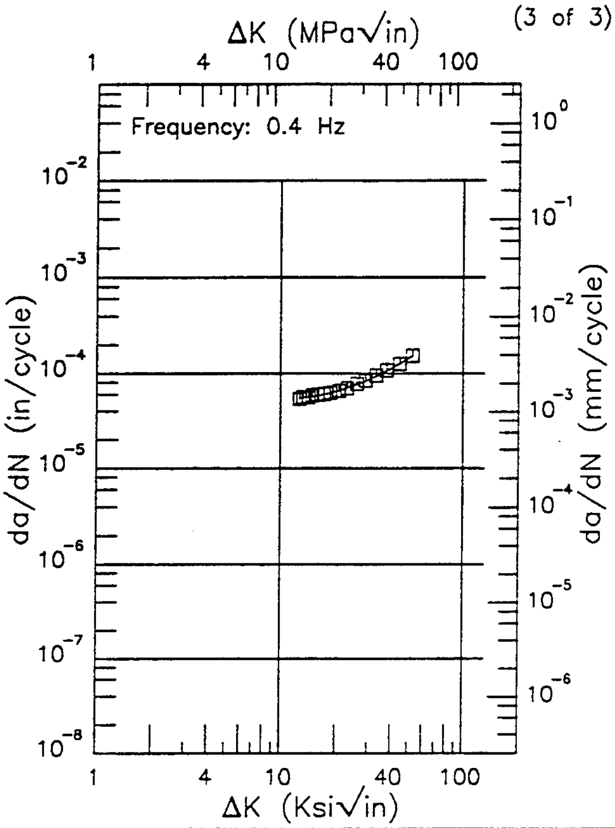
0. .5 .8 1.25 2.

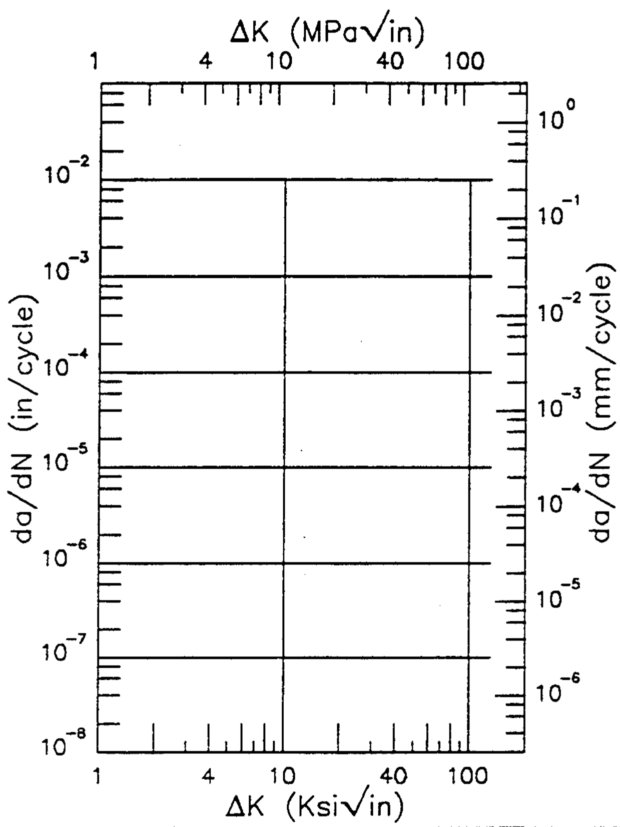
Figure 3.20.3.1.3

Condition/Ht: 750F TEMPER
Form:
Specimen Type:
Orientation:
Stress Ratio:
Environment: DIST WATER; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 89311

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.64 (min)	55.2
13.	55.5
16.	58.8
20.	65.0
25.	74.8
30.	86.1
35.	98.7
40.	113.
50.	144.
52.32 (max)	151.

ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

RMS % Error
1.42

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

Figure 3.20.3.1.3 (Concluded)

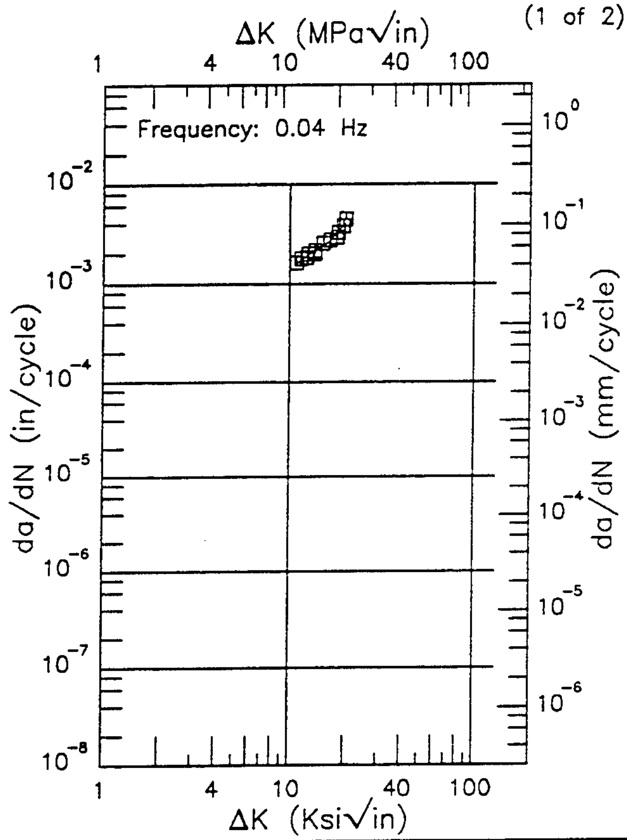
F

4340

Condition/Ht: 750F TEMPER
Form:
Specimen Type:
Orientation:
Stress Ratio:
Environment: DIST WATER;212°F

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 89311

(1 of 2)



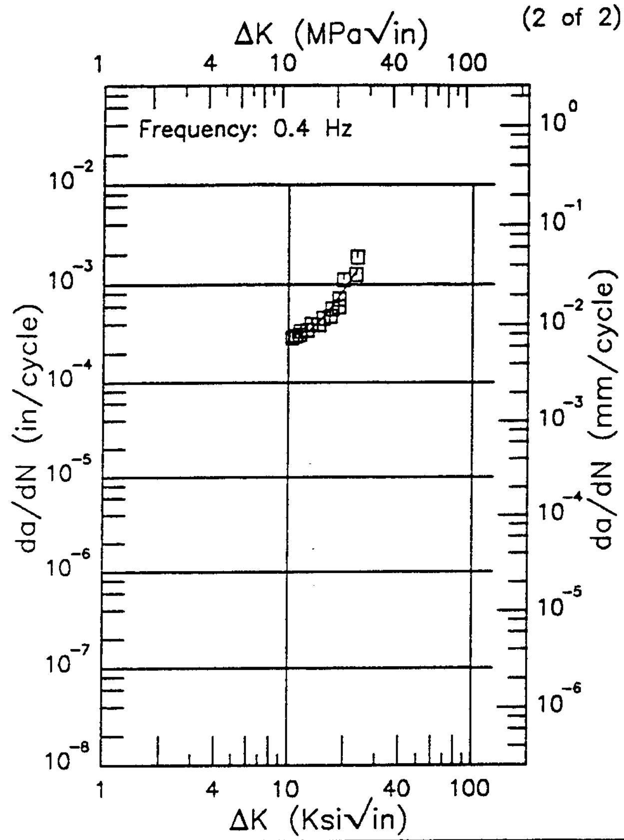
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.86 (min)	1604.
13.	2025.
16.	2608.
20.	4019.
20.01 (max)	4025.

RMS % Error 4.69

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.49 (min)	315.
13.	342.
16.	500.
20.	897.
23.50 (max)	1406.

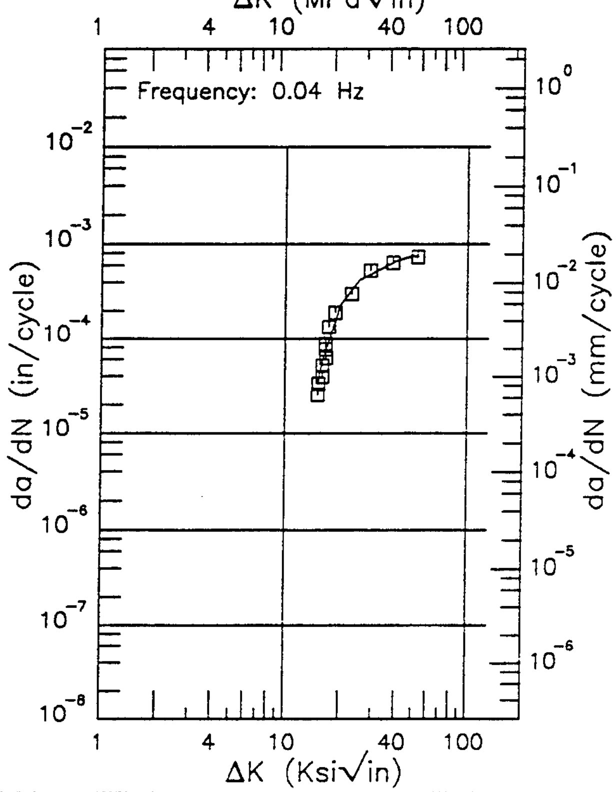
RMS % Error 14.20

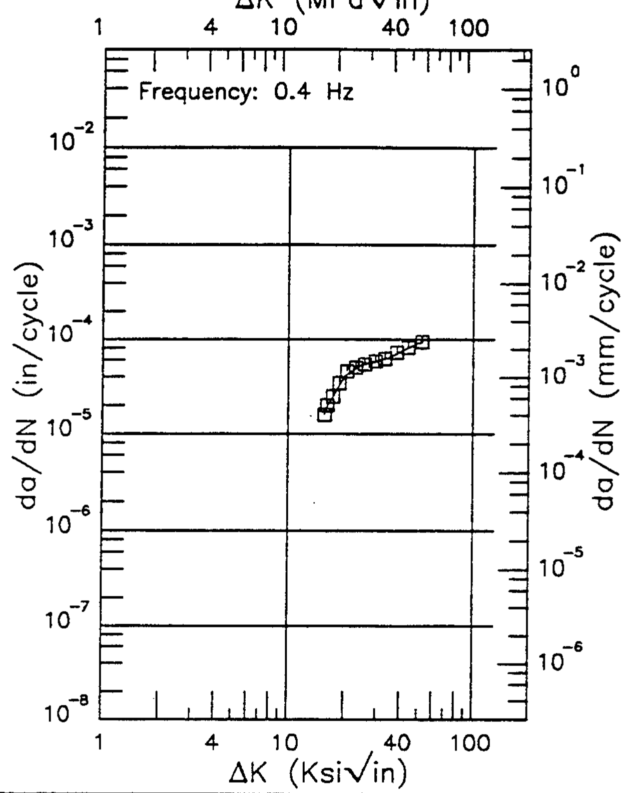
Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.30.3.1.4

Condition/Ht: 750F TEMPER	
Form:	Yield Strength:
Specimen Type:	Ult. Strength:
Orientation:	Specimen Thk:
Stress Ratio:	Specimen Width:
Environment: DIST WATER;32°F	Ref: 89311





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.03 (min)	33.0
16.	58.9
20.	231.
25.	416.
30.	504.
35.	580.
40.	677.
50.	754.
52.38 (max)	730.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.64 (min)	16.3
16.	18.4
20.	40.5
25.	54.1
30.	58.6
35.	64.2
40.	74.0
50.	91.4
52.38 (max)	92.8

RMS % Error	Life Prediction Ratio Summary
20.55	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
3.88	0. .5 .8 1.25 2.

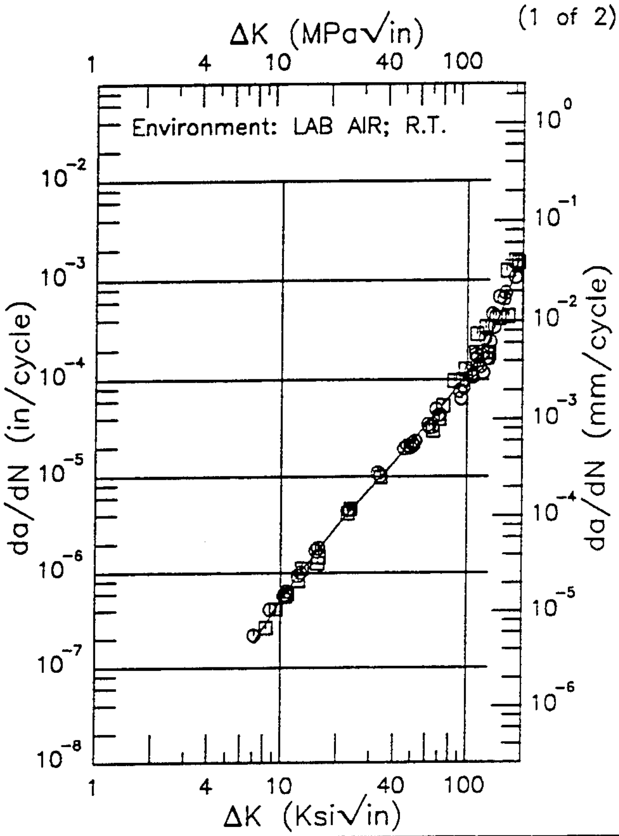
Figure 3.20.3.1.5

4340

E

Condition/Ht: MARTEMPERED	
Form: 0.5 in. Plate	Yield Strength: 191 – 201.5 ksi
Specimen Type: CCP (max stress specified)	Ult. Strength: 196 – 209 ksi
Orientation: L–T	Specimen Thk: 0.246 – 0.251 in.
Stress Ratio: 0.02	Specimen Width:
Frequency:	Ref: MA012

(1 of 2)



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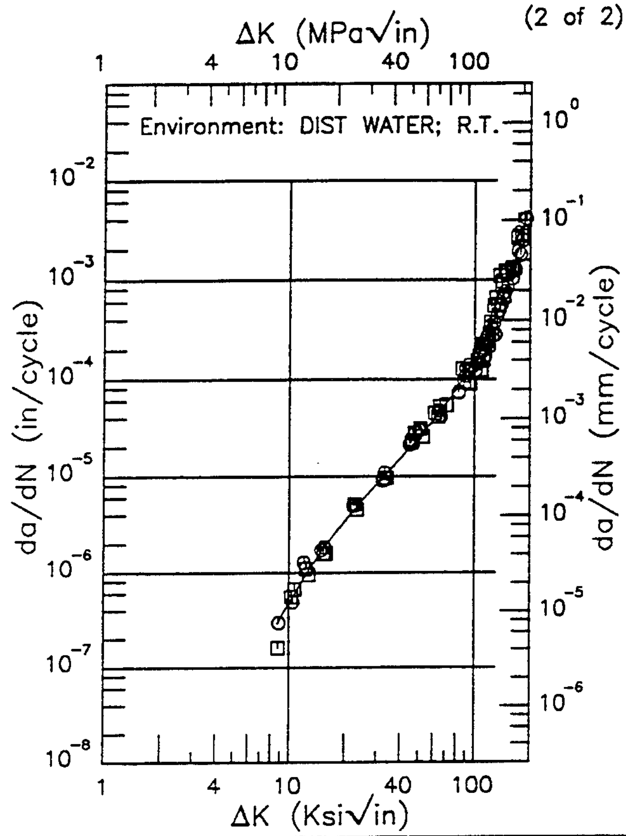


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.13 (min)	0.183
8.	0.264
9.	0.379
10.	0.516
13.	1.06
16.	1.80
20.	3.06
25.	5.08
30.	7.59
40.	14.1
50.	23.0
60.	34.4
80.	66.7
100.	115.
130.	246.
160.	579.
188.45 (max)	1485.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.73 (min)	0.293
9.	0.329
10.	0.481
13.	1.12
16.	1.98
20.	3.43
25.	5.66
30.	8.34
40.	15.2
50.	24.6
60.	37.5
80.	79.1
100.	155.
130.	411.
160.	1238.
189.12 (max)	4189.

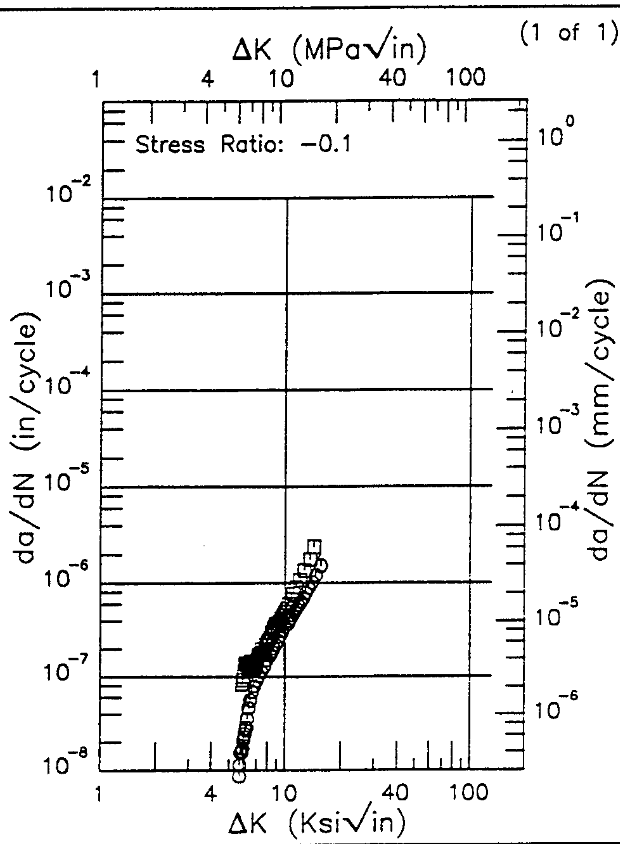
RMS % Error	Life Prediction Ratio Summary
23.49	0. .5 .8 1.25 2.

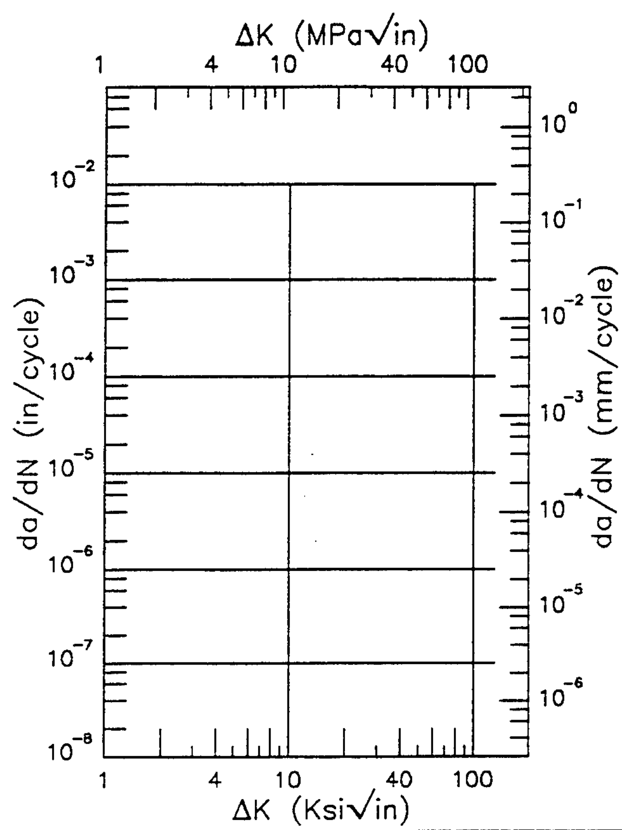
RMS % Error	Life Prediction Ratio Summary
23.03	0. .5 .8 1.25 2.

Figure 3.20.3.1.6

Condition/Ht: UTS=150KSI
Form:
Specimen Type: CCP (max load specified)
Orientation: L–T
Frequency: 2 – 5 Hz
Environment: LAB AIR; RT

Yield Strength: 150 ksi
Ult. Strength:
Specimen Thk: 0.25 in.
Specimen Width: 3.9 in.
Ref: WL005





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.69 (min)	0.0275
6.	0.0450
7.	0.131
8.	0.237
9.	0.341
10.	0.440
13.	0.879
15.54 (max)	2.01

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
54.59	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.20.3.1.7

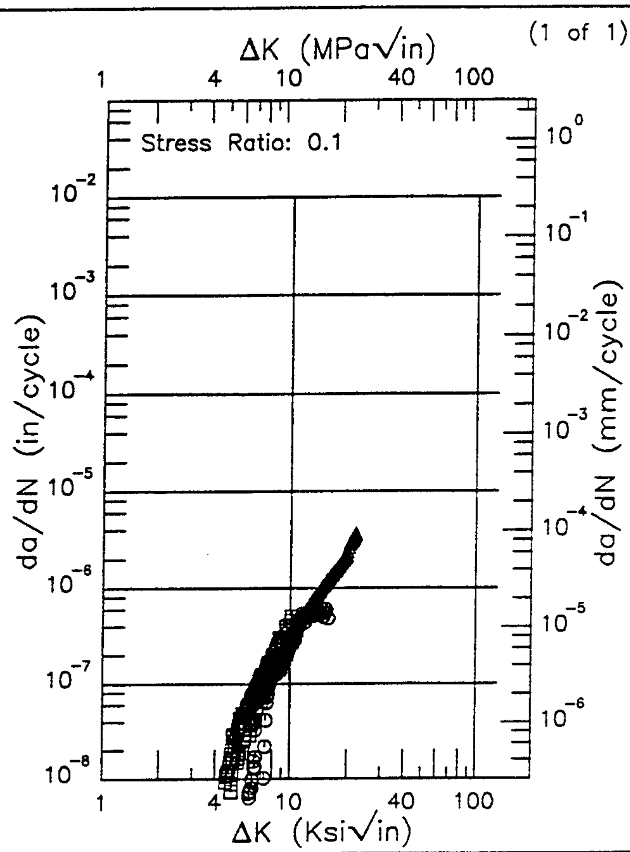
R

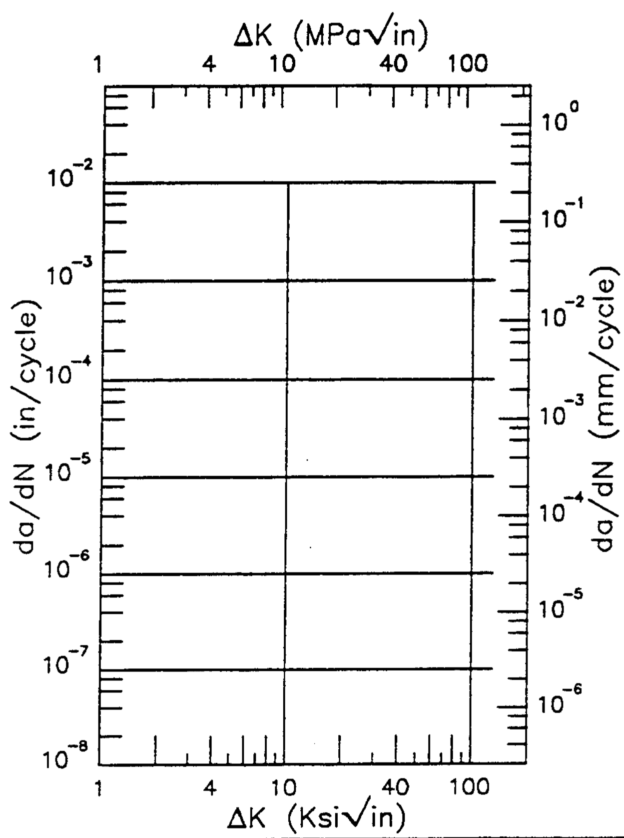
4340

Condition/Ht: UTS=150KSI
Form: Forging
Specimen Type: CT
Orientation: L–T
Frequency: 30 Hz
Environment: LAB AIR; RT

Yield Strength: 150 ksi
Ult. Strength:
Specimen Thk: 0.25 – 0.251 in.
Specimen Width: 2 – 2.003 in.
Ref: SW001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.55 (min)	0.0112
5.	0.0180
6.	0.0413
7.	0.0778
8.	0.129
9.	0.197
10.	0.281
13.	0.651
16.	1.23
20.	2.44
21.97 (max)	3.29

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
31.84

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

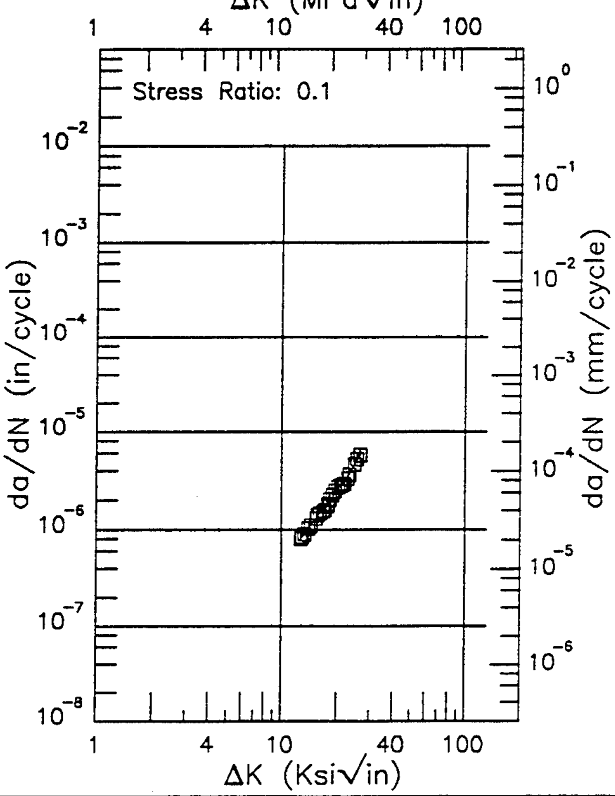
RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

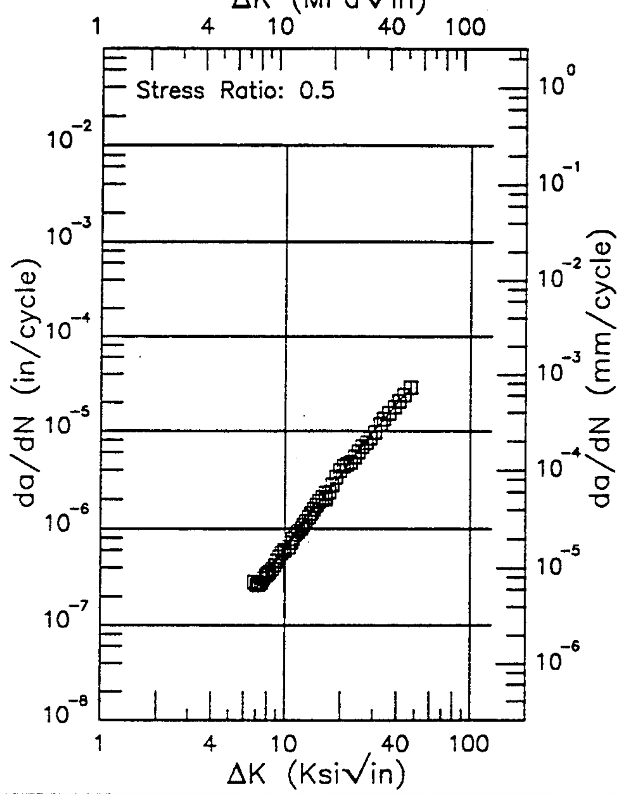
Figure 3.20.3.1.8

Condition/Ht: UTS=160KSI	Yield Strength: 158.5 ksi
Form: 4.25 in. Round Bar	Ult. Strength: 168.1 ksi
Specimen Type: CT	Specimen Thk: 0.5 in.
Orientation: L–T	Specimen Width: 2 in.
Frequency: 7 Hz	Ref: DA001
Environment: LAB AIR; RT	

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.63 (min)	0.780
13.	0.847
16.	1.44
20.	2.47
25.	4.72
26.50 (max)	5.79

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.83 (min)	0.229
7.	0.244
8.	0.344
9.	0.466
10.	0.611
13.	1.20
16.	2.05
20.	3.60
25.	6.27
30.	9.78
35.	14.1
40.	19.3
47.14 (max)	27.9

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
4.21	0. .5 .8 1.25 2.	5.82	0. .5 .8 1.25 2.

Figure 3.20.3.1.9

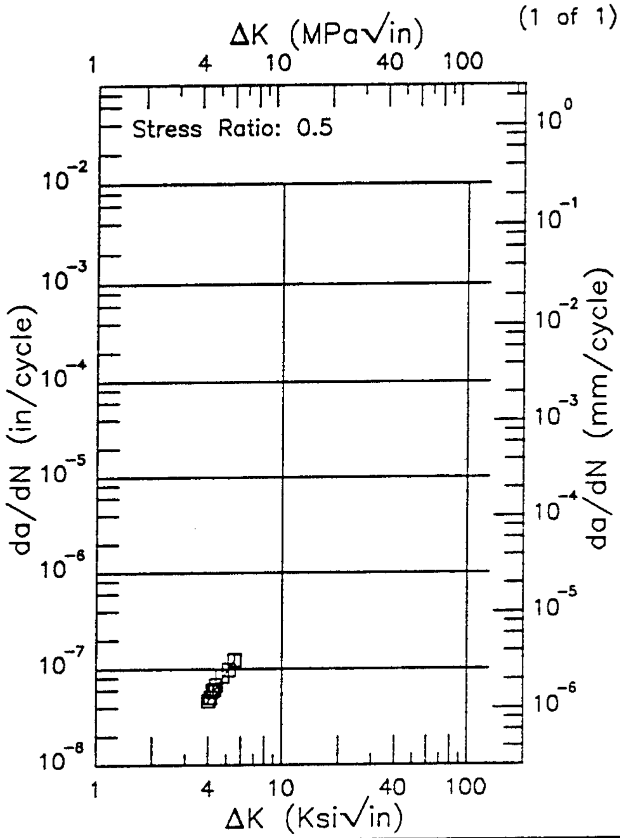
4340

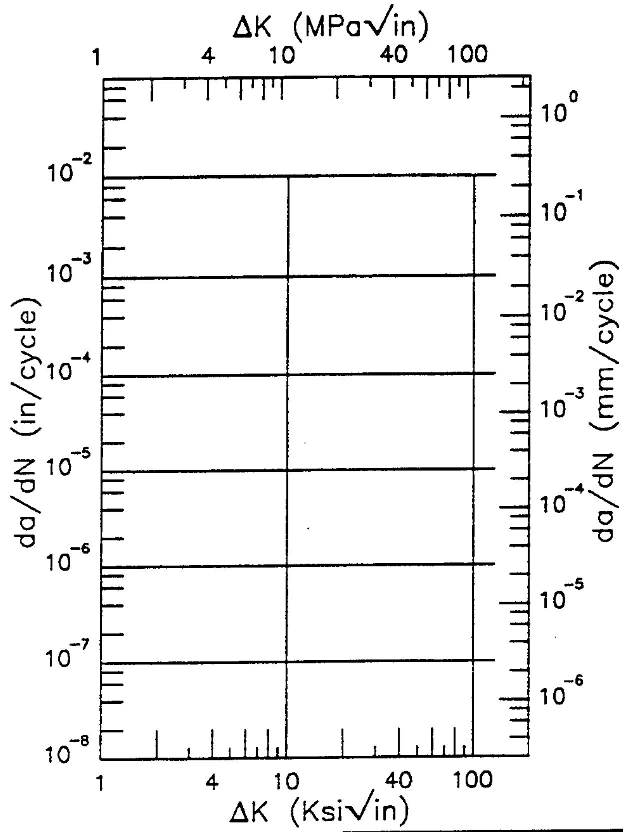
R

Condition/Ht: UTS=160KSI
Form: 4.25 in. Round Bar
Specimen Type: CT
Orientation: L-T
Frequency: 7 Hz
Environment: LAB AIR; RT

Yield Strength: 158.5 ksi
Ult. Strength: 168.1 ksi
Specimen Thk: 0.25 in.
Specimen Width: 2 in.
Ref: DA001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
3.99 (min)	0.0455
4.	0.0461
5.	0.0930
5.53 (max)	0.123

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error
5.63

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

Figure 3.20.3.1.10

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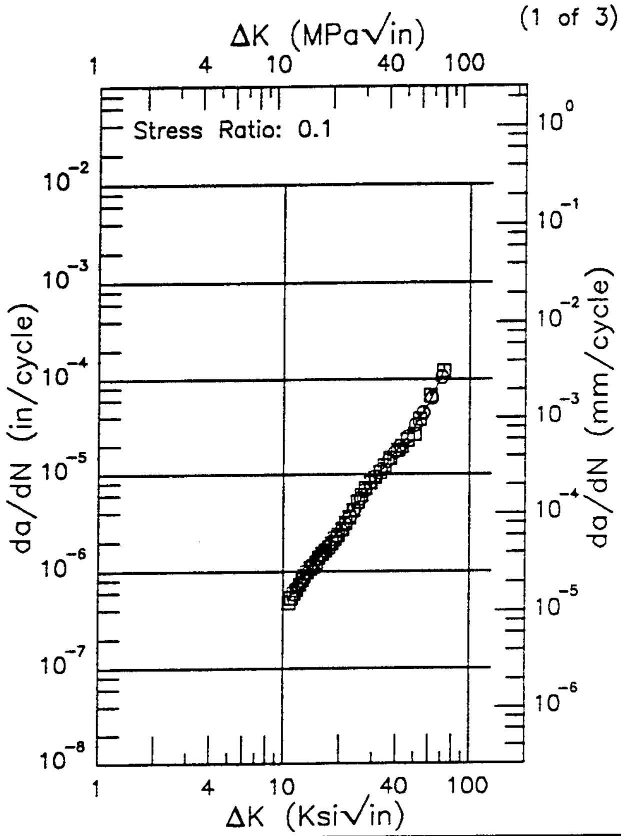
4340

R

Condition/Ht: UTS=160-180KSI
Form: 1 in. Bar
Specimen Type: CT
Orientation: L-T
Frequency: 20 Hz
Environment: LAB AIR; RT

Yield Strength: 167 ksi
Ult. Strength:
Specimen Thk: 0.528 - 0.532 in.
Specimen Width: 2 in.
Ref: SW001

(1 of 3)

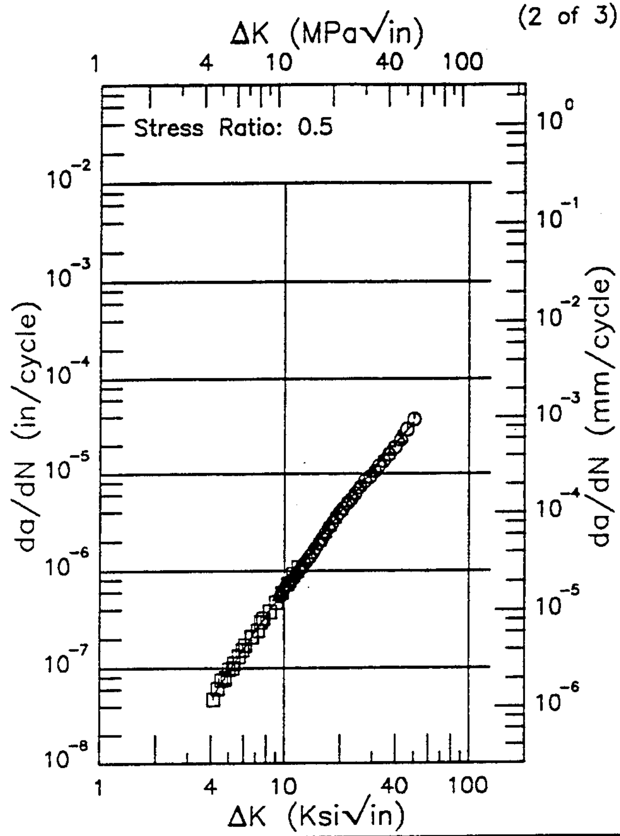


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.65 (min)	0.517
13.	0.847
16.	1.46
20.	2.69
25.	4.97
30.	8.17
35.	12.3
40.	17.4
50.	30.7
60.	54.7
70.	107.
71.78 (max)	122.

RMS % Error
5.28

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.12 (min)	0.0512
5.	0.0910
6.	0.154
7.	0.239
8.	0.347
9.	0.481
10.	0.641
13.	1.29
16.	2.21
20.	3.90
25.	6.76
30.	10.5
35.	15.1
40.	20.6
50.	34.1
50.26 (max)	34.5

RMS % Error
4.35

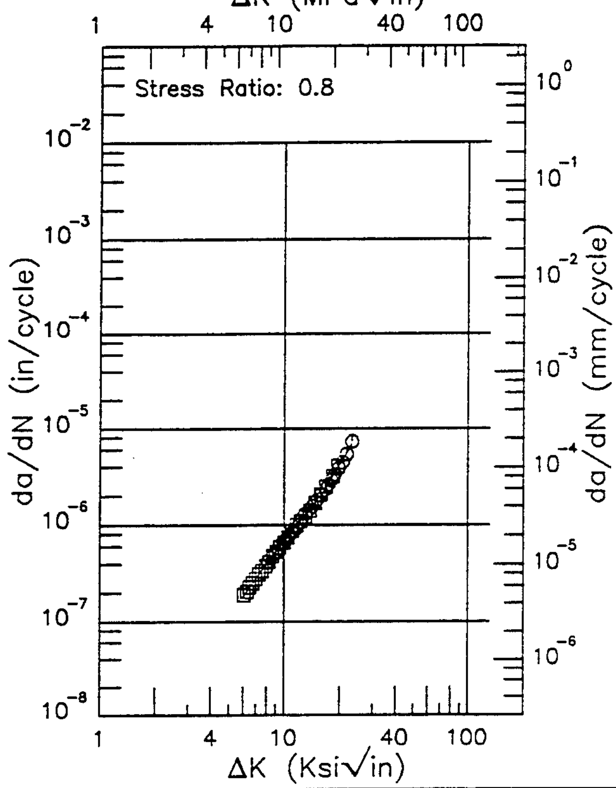
Life Prediction Ratio Summary
0. .5 .8 1.25 2.

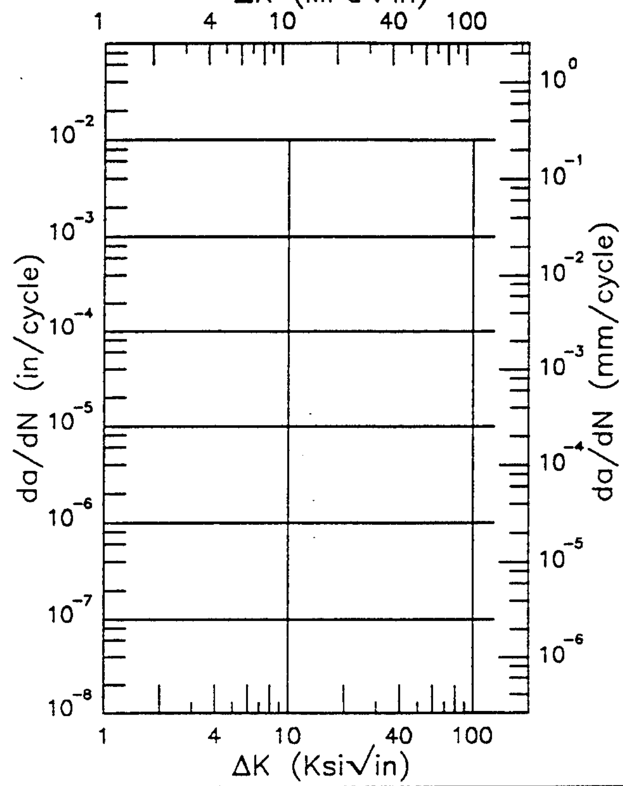
Figure 3.20.3.1.11

Condition/Ht: UTS=160-180KSI
Form: 1 in. Bar
Specimen Type: CT
Orientation: L-T
Frequency: 20 Hz
Environment: LAB AIR; RT

Yield Strength: 167 ksi
Ult. Strength:
Specimen Thk: 0.528 - 0.532 in.
Specimen Width: 2 in.
Ref: SW001

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.01 (min)	0.181
7.	0.280
8.	0.396
9.	0.527
10.	0.675
13.	1.25
16.	2.13
20.	4.16
23.09 (max)	6.90

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
2.26	0. .5 .8 1.25 2.

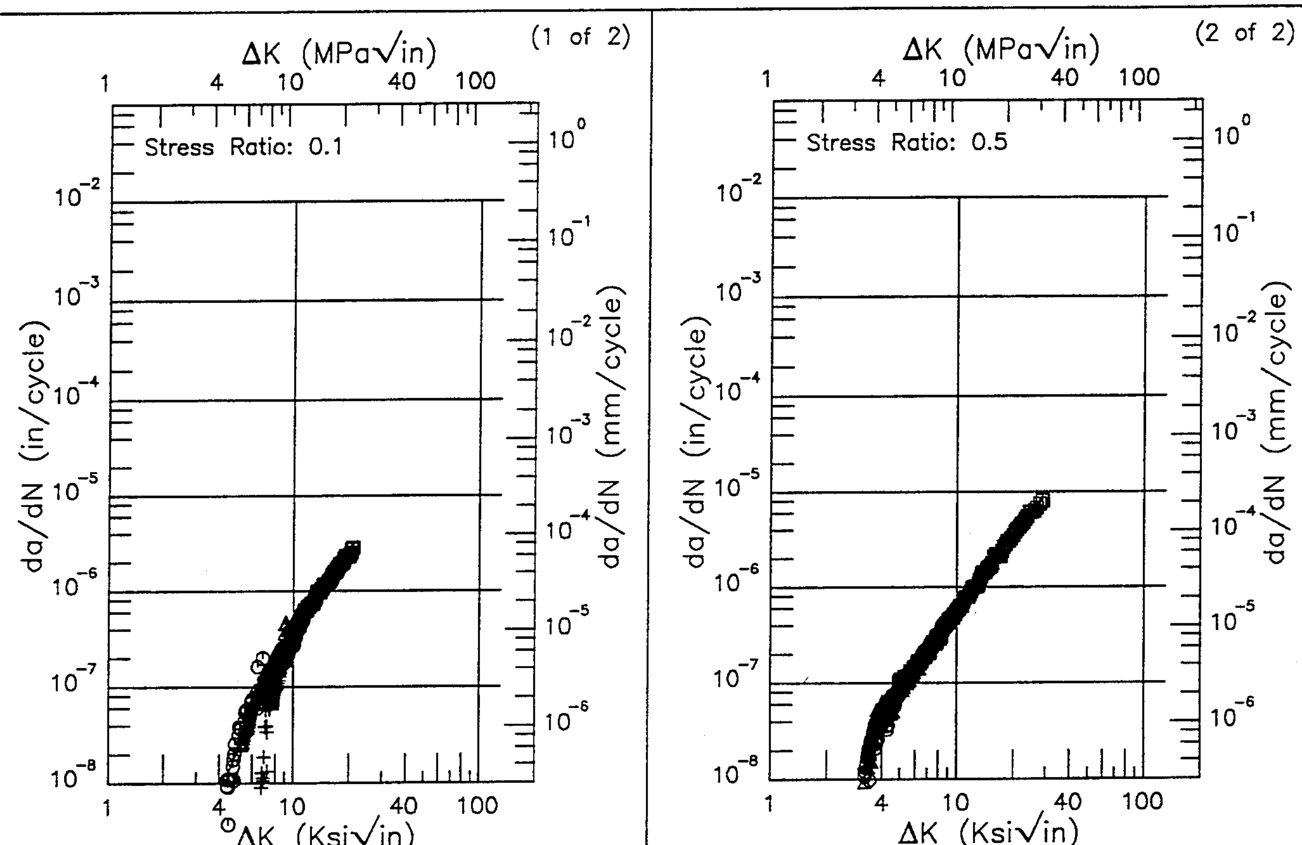
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.20.3.1.11 (Concluded)

R 4340

Condition/Ht: UTS=180KSI
Form: Forging
Specimen Type: CT
Orientation: L-T
Frequency: 20 – 30 Hz
Environment: LAB AIR; RT

Yield Strength: 180 ksi
Ult. Strength:
Specimen Thk: 0.249 – 0.251 in.
Specimen Width: 1.503 – 2.002 in.
Ref: SW001



Stress Ratio: 0.1

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
4.38 (min)	0.0118
5.	0.0225
6.	0.0512
7.	0.0967
8.	0.161
9.	0.246
10.	0.352
13.	0.794
16.	1.42
20.	2.52
20.75 (max)	2.76

Stress Ratio: 0.5

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
3.22 (min)	0.0193
3.5	0.0259
4.	0.0409
5.	0.0837
6.	0.144
7.	0.224
8.	0.322
9.	0.441
10.	0.580
13.	1.13
16.	1.92
20.	3.40
25.	6.11
28.53 (max)	8.77

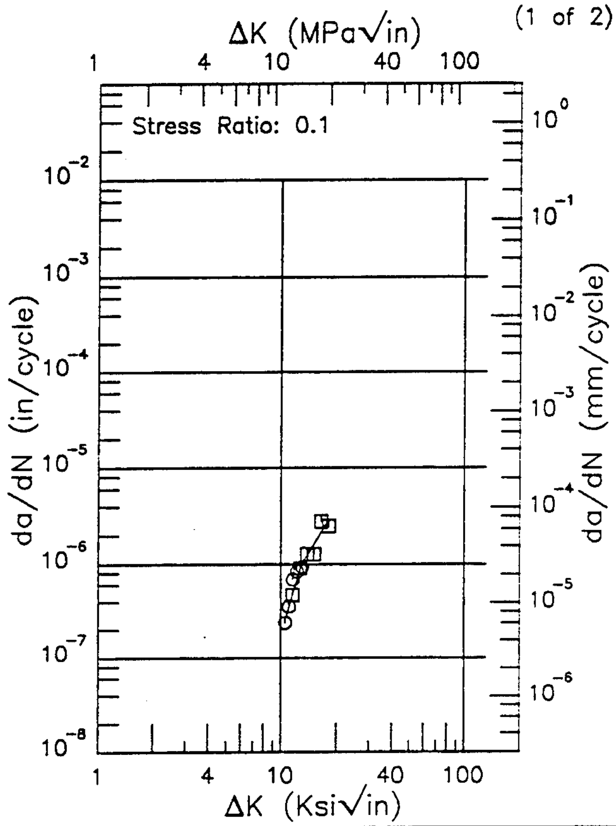
RMS % Error	Life Prediction Ratio Summary
31.11	0. .5 .8 1.25 2.
15.10	0. .5 .8 1.25 2.

Figure 3.20.3.1.12

Condition/Ht: UTS=180KSI
Form: 4.25 in. Round Bar
Specimen Type: CT
Orientation: L-T
Frequency: 20 Hz
Environment: LAB AIR;650°F

Yield Strength: 192.9 ksi
Ult. Strength: 204.1 ksi
Specimen Thk: 0.25 in.
Specimen Width: 2 in.
Ref: DA001

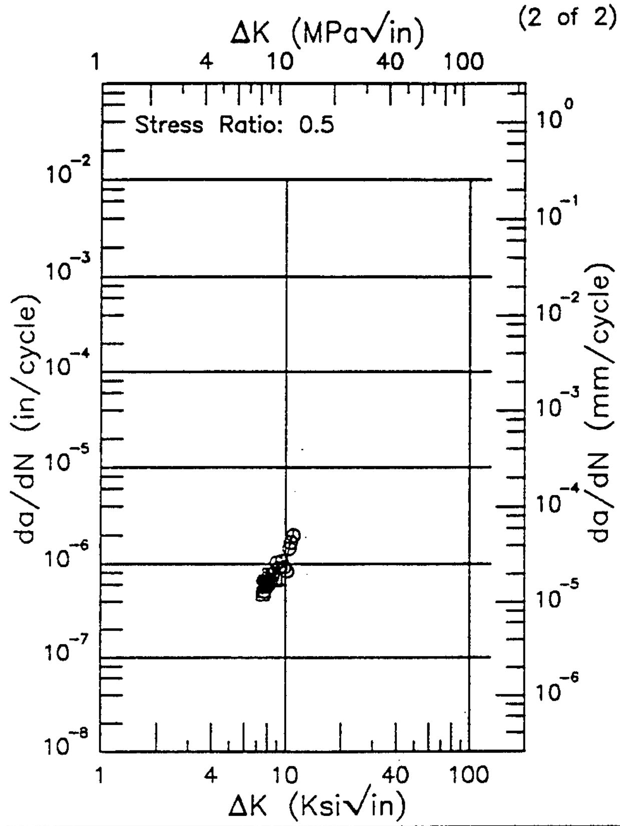
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.52 (min)	0.249
13.	0.997
16.	1.95
18.00 (max)	2.92

RMS % Error	Life Prediction Ratio Summary
20.99	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.52 (min)	0.511
8.	0.676
9.	0.813
10.	1.04
10.96 (max)	2.00

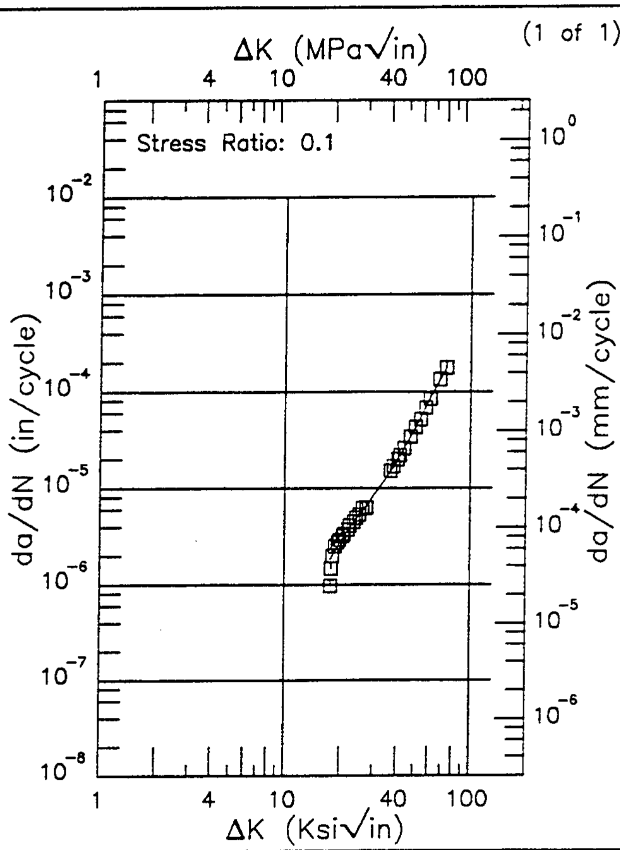
RMS % Error	Life Prediction Ratio Summary
11.33	0. .5 .8 1.25 2.

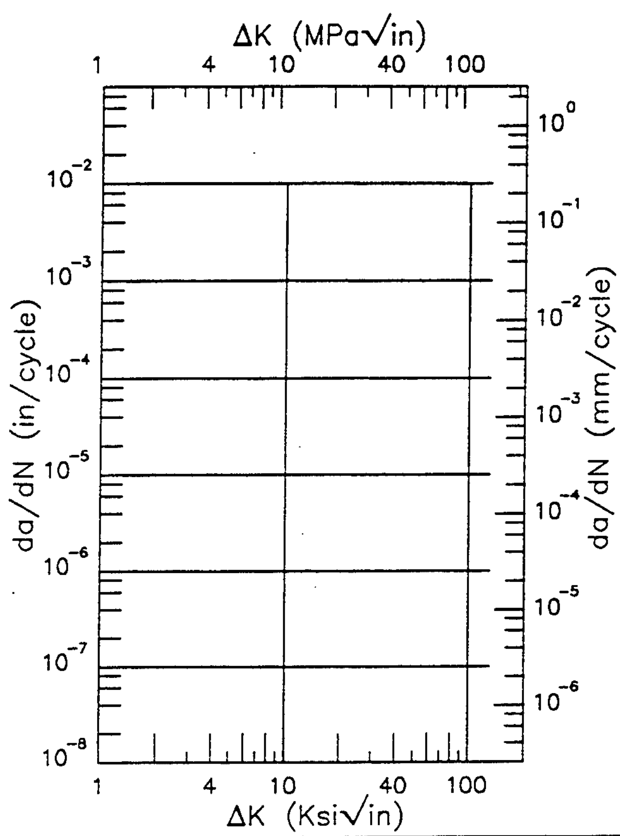
Figure 3.20.3.1.13

R 4340

Condition/Ht: UTS=180KSI
Form: 4.25 in. Round Bar
Specimen Type: CT
Orientation: L-T
Frequency: 7 Hz
Environment: LAB AIR;650°F

Yield Strength: 192.9 ksi
Ult. Strength: 204.1 ksi
Specimen Thk: 0.5 in.
Specimen Width: 2 in.
Ref: DA001





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
17.58 (min)	1.81
20.	2.79
25.	5.27
30.	8.45
35.	12.7
40.	18.7
50.	40.2
60.	81.9
70.	145.
73.82 (max)	173.

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
11.24	0. .5 .8 1.25 2.

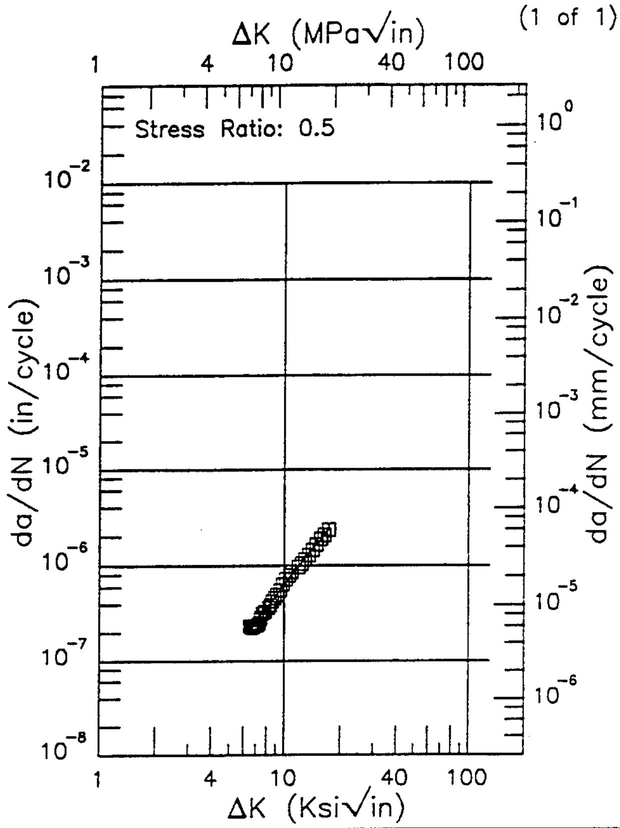
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

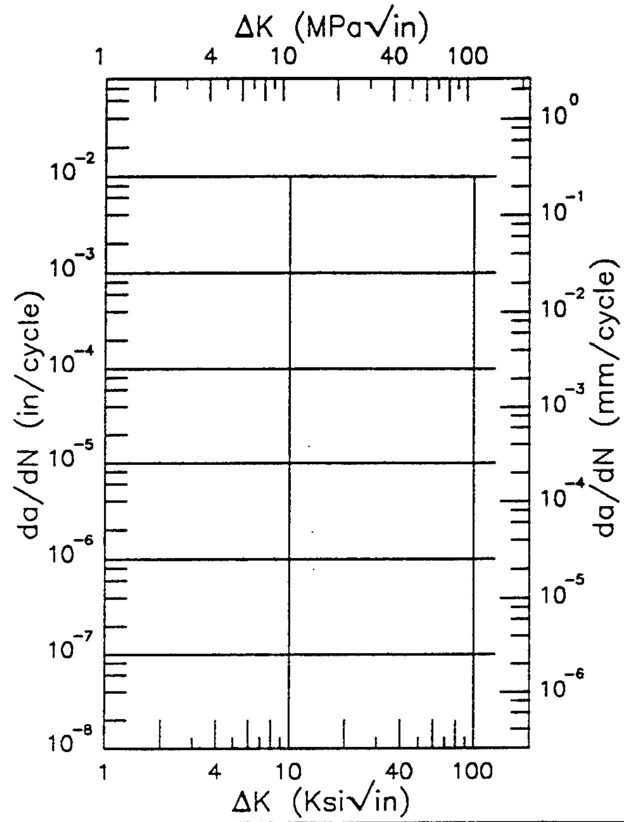
Figure 3.20.3.1.14

Condition/Ht: UTS=180KSI
Form: 4.25 in. Round Bar
Specimen Type: CT
Orientation: L–T
Frequency: 7 Hz
Environment: LAB AIR; RT

Yield Strength: 192.9 ksi
Ult. Strength: 204.1 ksi
Specimen Thk: 0.5 in.
Specimen Width: 1.97 in.
Ref: DA001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.47 (min)	0.208
7.	0.247
8.	0.348
9.	0.483
10.	0.648
13.	1.20
16.	1.90
17.26 (max)	2.41

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
4.12	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.20.3.1.15

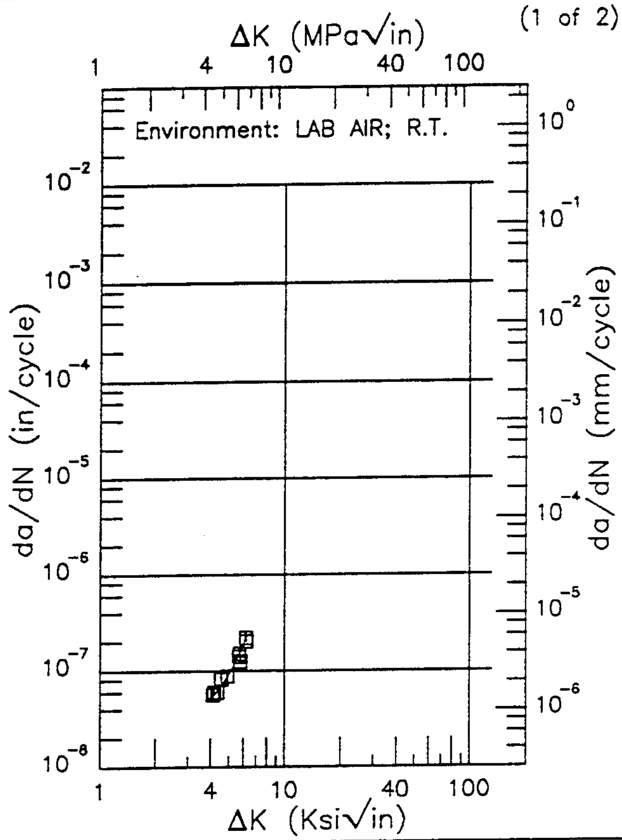
E

4340

Condition/Ht: UTS=180KSI
Form: 4.25 in. Round Bar
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.5
Frequency: 7 Hz

Yield Strength: 192.9 ksi
Ult. Strength: 204.1 ksi
Specimen Thk: 0.25 – 0.375 in.
Specimen Width: 1.5 – 2 in.
Ref: DA001

(1 of 2)



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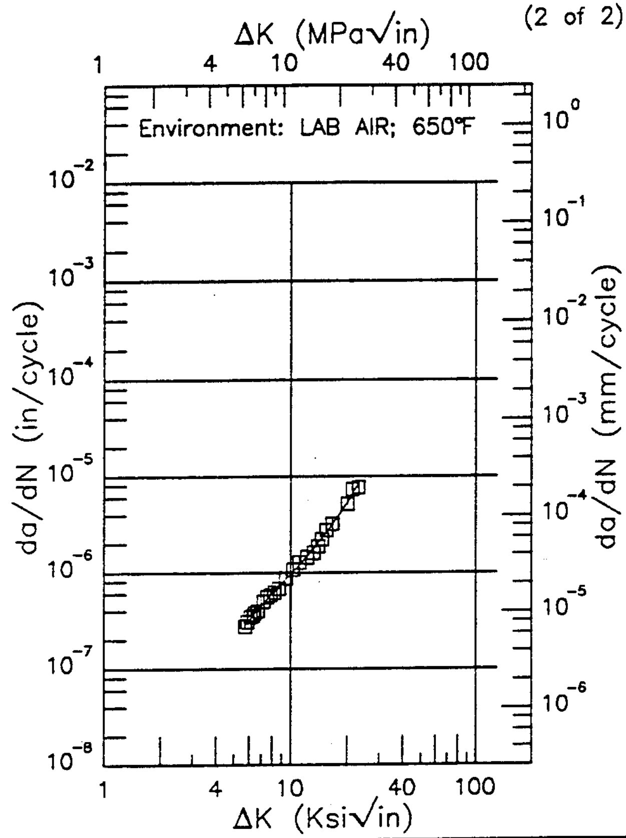


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.08 (min)	0.0528
5.	0.0924
6.	0.178
6.20 (max)	0.224

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.72 (min)	0.282
6.	0.317
7.	0.454
8.	0.606
9.	0.773
10.	0.960
13.	1.68
16.	2.78
20.	5.28
22.85 (max)	8.29

RMS % Error	Life Prediction Ratio Summary
11.20	0. .5 .8 1.25 2.

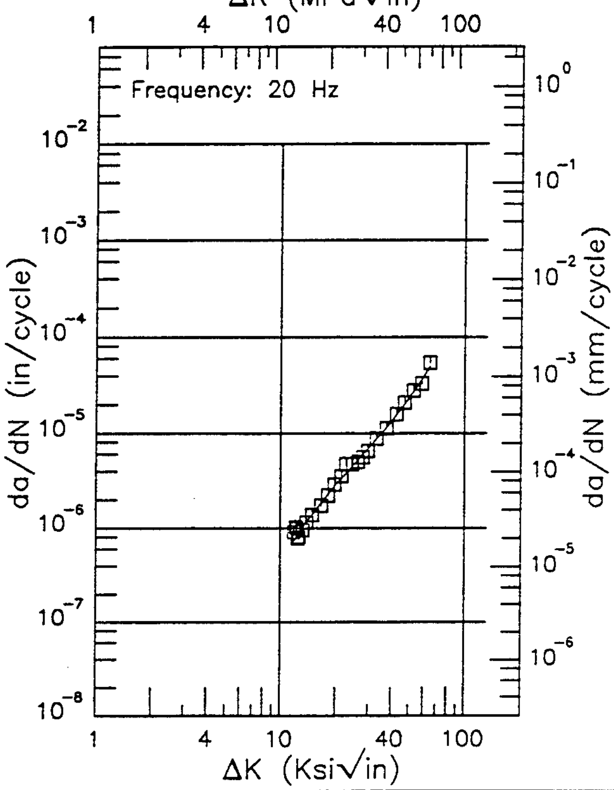
RMS % Error	Life Prediction Ratio Summary
4.72	0. .5 .8 1.25 2.

Figure 3.20.3.1.16

Condition/Ht: UTS=180KSI
Form: 4.25 in. Round Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.1
Environment: LAB AIR; RT

Yield Strength: 192.9 ksi
Ult. Strength: 204.1 ksi
Specimen Thk: 0.251 - 0.501 in.
Specimen Width: 1.975 - 1.978 in.
Ref: DA001

(1 of 2)



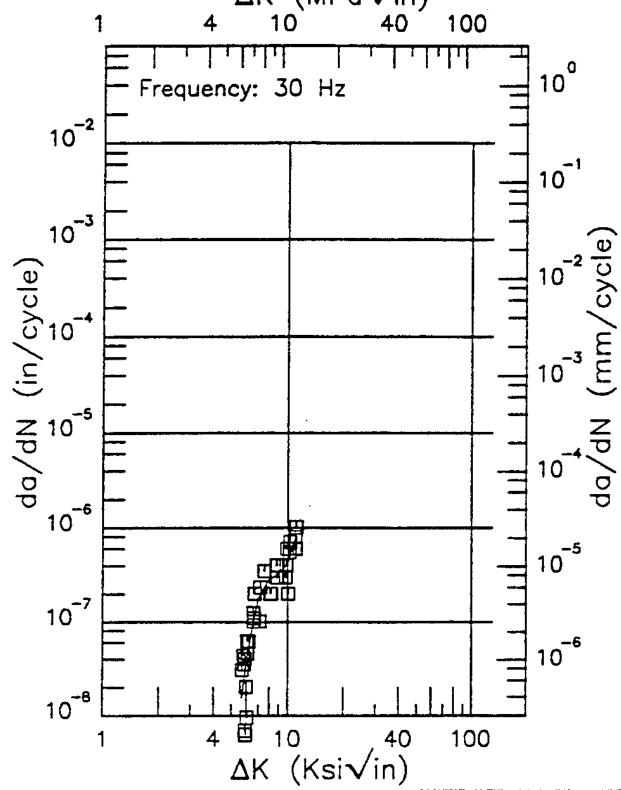
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.85 (min)	0.736
13.	0.969
16.	1.69
20.	2.89
25.	4.73
30.	7.01
35.	9.85
40.	13.4
50.	23.4
60.	39.2
64.66 (max)	49.4

RMS % Error 11.24

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.69 (min)	0.0156
6.	0.0395
7.	0.185
8.	0.286
9.	0.330
10.	0.423
11.14 (max)	0.819

RMS % Error 47.81

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.20.3.1.17

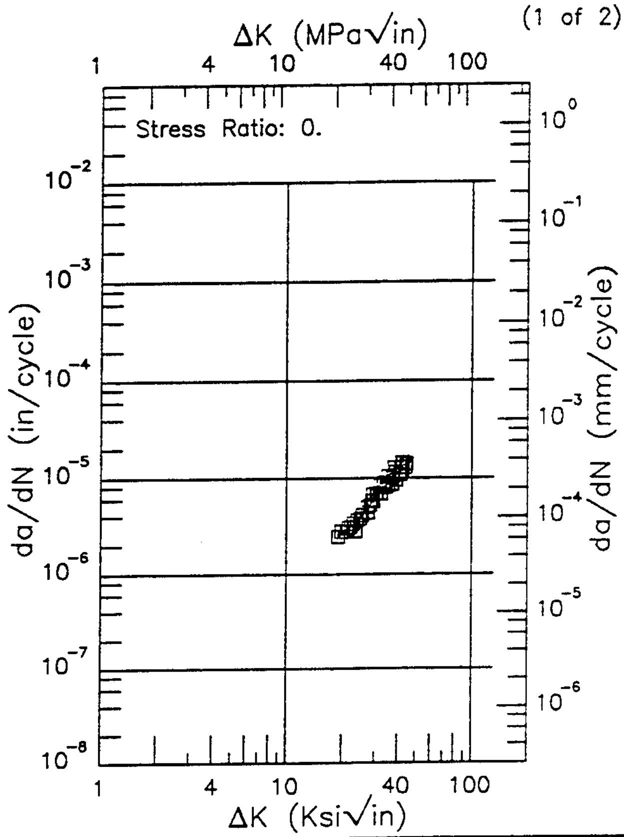
4340

R

Condition/Ht: UTS=180-200KSI
Form: 1 in. Plate
Specimen Type: CCP (max stress specified)
Orientation:
Frequency: 10 Hz
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.163 in.
Specimen Width: 5 in.
Ref: BW002

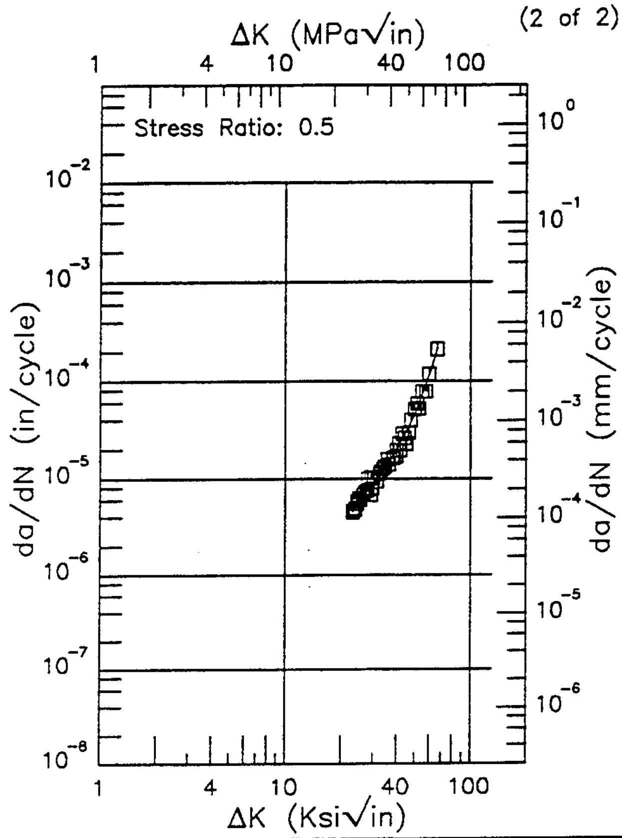
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.90 (min)	2.60
20.	2.68
25.	3.87
30.	6.12
35.	8.98
40.	11.6
44.30 (max)	12.8

RMS % Error	Life Prediction Ratio Summary
9.51	0. .5 .8 1.25 2.

(2 of 2)



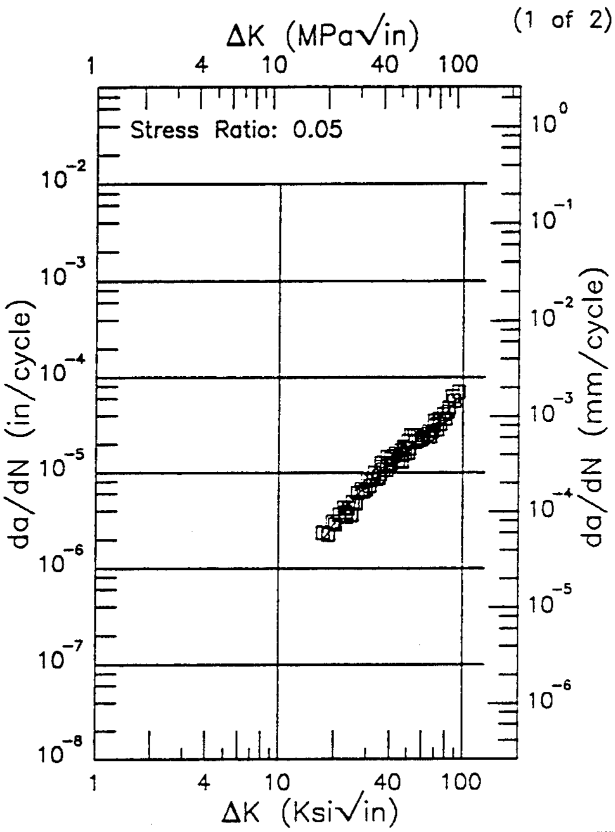
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
22.90 (min)	4.62
25.	5.83
30.	9.11
35.	13.4
40.	19.7
50.	45.1
60.	115.
66.10 (max)	214.

RMS % Error	Life Prediction Ratio Summary
10.70	0. .5 .8 1.25 2.

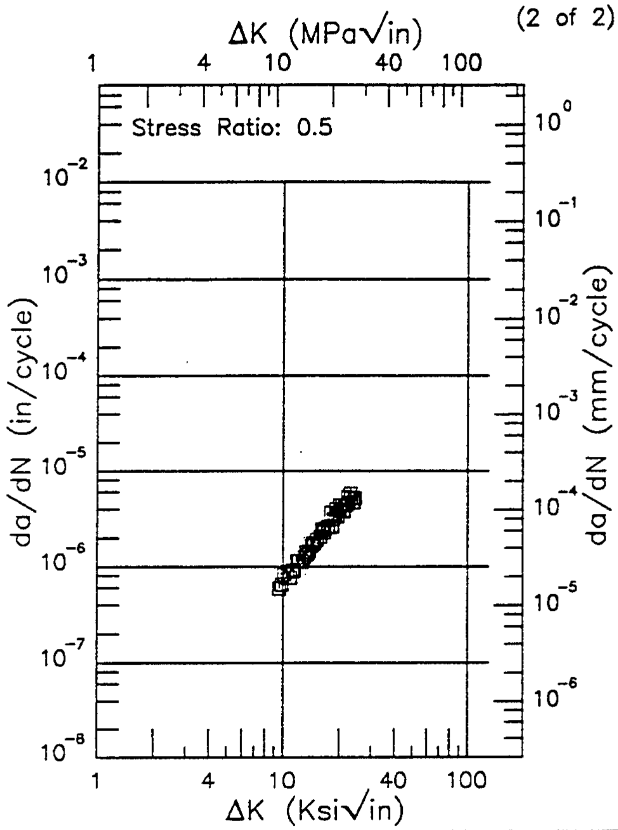
Figure 3.20.3.1.18

Condition/Ht: UTS=180–200KSI
Form: 1 in. Bar
Specimen Type: CCP (max stress specified)
Orientation: L–T
Frequency: 3 Hz
Environment: H.H.A.; RT

Yield Strength: 182.5 ksi
Ult. Strength: 193.7 ksi
Specimen Thk: 0.4 in.
Specimen Width: 4 in.
Ref: BW001



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.32 (min)	1.97
20.	2.94
25.	5.01
30.	7.27
35.	9.66
40.	12.2
50.	17.8
60.	24.4
70.	32.5
80.	42.7
90.	55.5
93.91 (max)	61.5



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.47 (min)	0.648
10.	0.714
13.	1.29
16.	2.21
20.	3.78
24.31 (max)	5.43

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
11.53	0. .5 .8 1.25 2.	8.25	0. .5 .8 1.25 2.

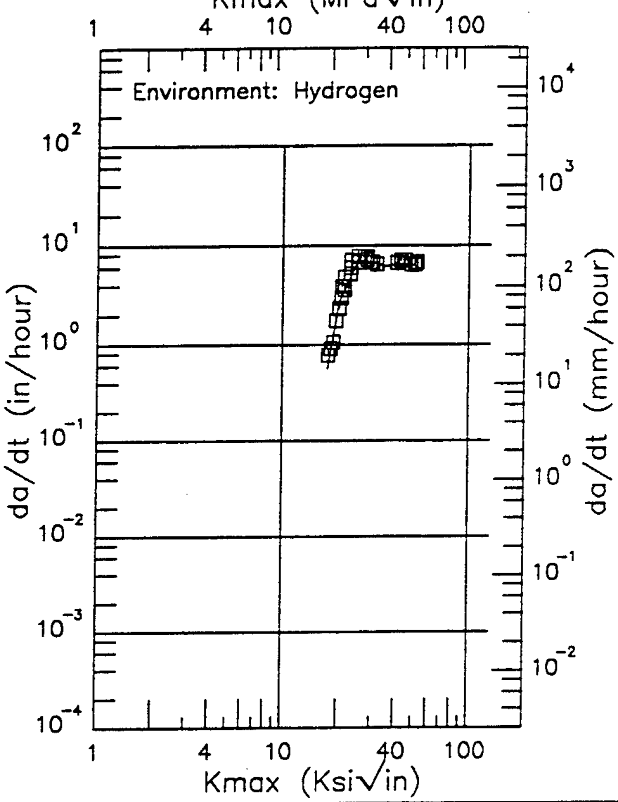
Figure 3.20.3.1.19

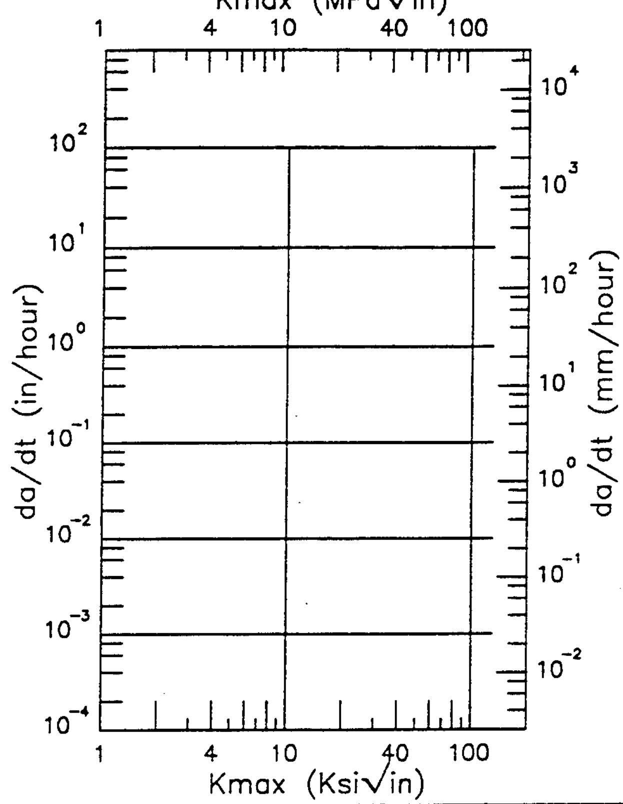
4340

Condition/Ht:
Form:
Specimen Type:
Orientation:
Yield Strength:
Ult. Strength:

Specimen Thk:
Specimen Width:
A_0:
K_{Iscc}:
Ref: 84310

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3} in/hour)
17.50 (min)	568.
20.	2663.
25.	7064.
30.	6903.
35.	6209.
40.	6534.
50.	6463.
51.50 (max)	6155.

Kmax (Ksi√in)	da/dt (10^{-3} in/hour)

RMS % Error
16.12

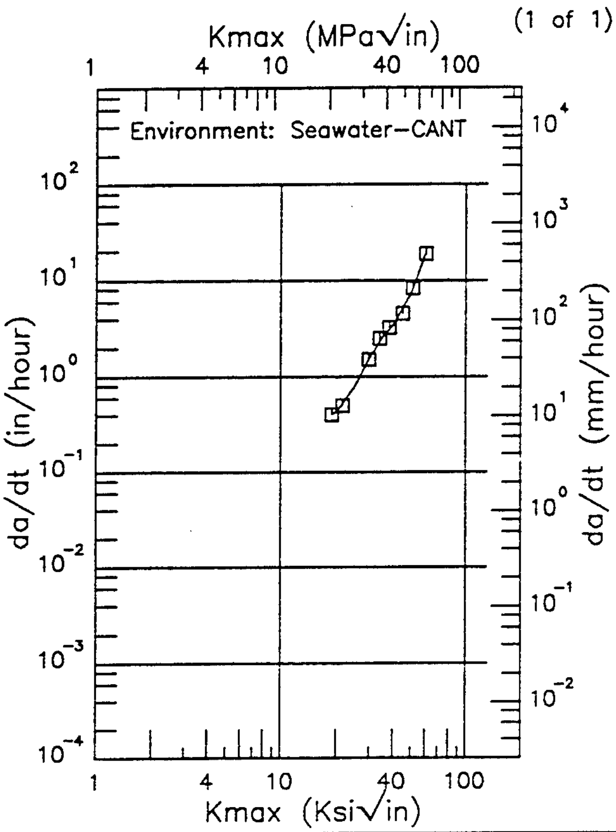
RMS % Error

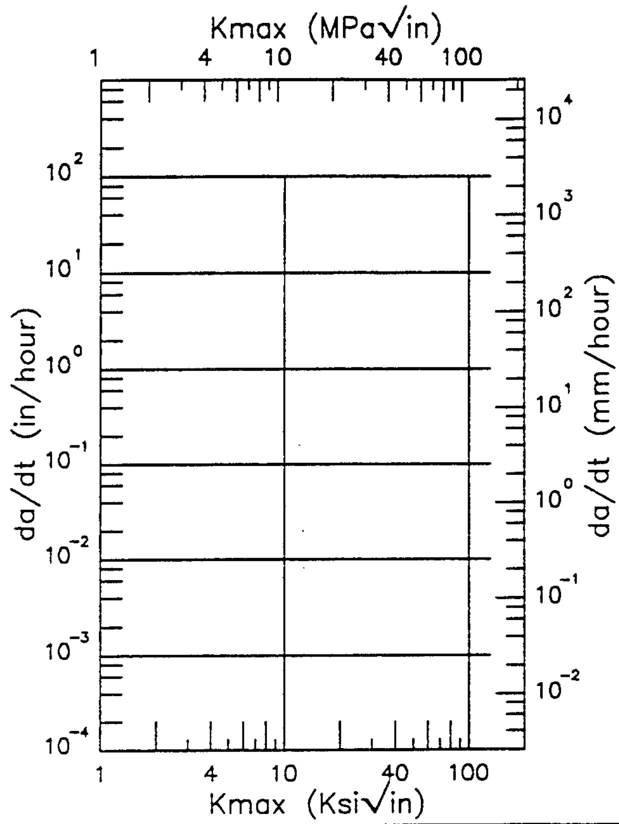
Figure 3.20.3.2.1

Condition/Ht:
Form: Plate
Specimen Type: CB
Orientation: T-L
Yield Strength: 225 ksi
Ult. Strength:

Specimen Thk:
Specimen Width:
Ao:
KIscc: 5 ksi
Ref: 70887

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
18.80 (min)	410.
20.	429.
25.	799.
30.	1622.
35.	2579.
40.	3470.
50.	7328.
60.00 (max)	18732.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error	
5.49	

RMS % Error	

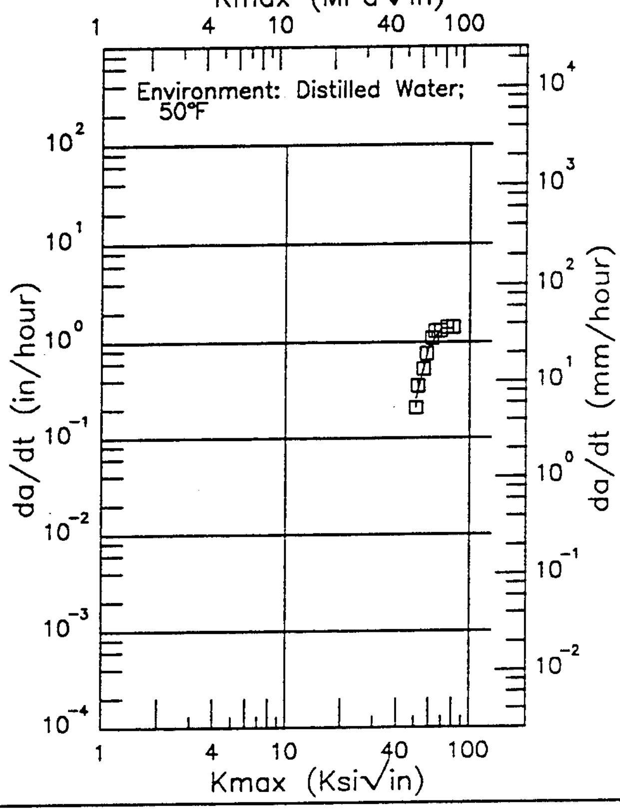
Figure 3.20.3.2.2

4340

Condition/Ht: TEMPER 400F 1HR
Form: 0.25 in. Plate
Specimen Type: CNT
Orientation:
Yield Strength: 195 ksi
Ult. Strength:

Specimen Thk: 0.25 in.
Specimen Width: 2 in.
A_o:
K_{Iscc}:
Ref: 84309

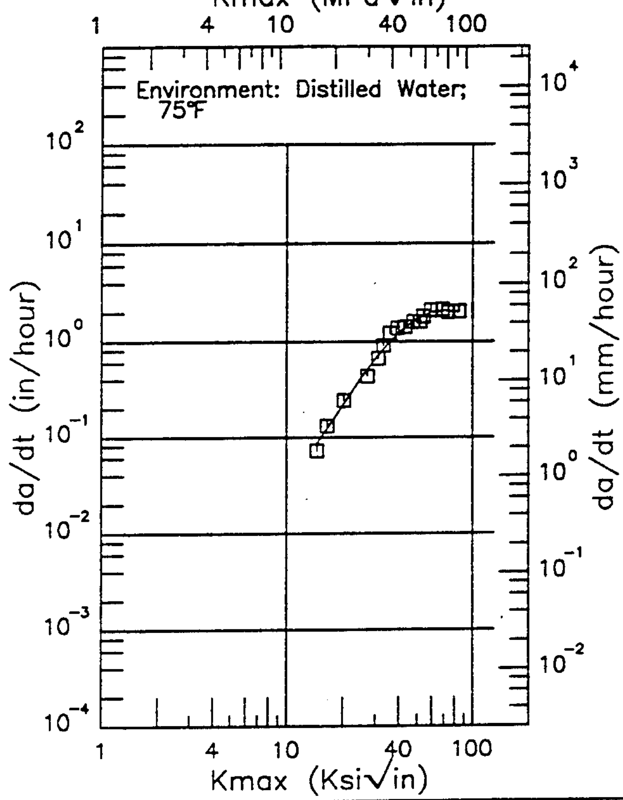
(1 of 7)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
51.00 (min)	256.
60.	893.
70.	1384.
80.	1383.
81.00 (max)	1367.

RMS % Error 11.48

(2 of 7)



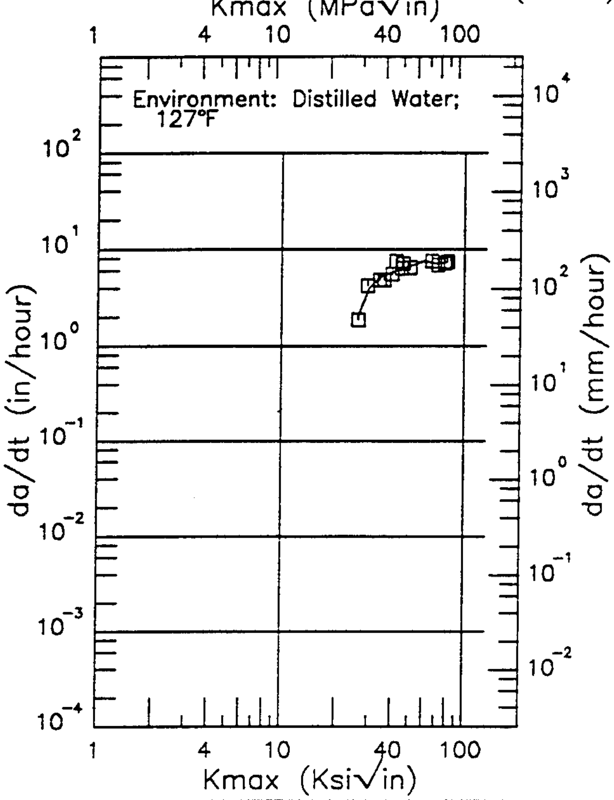
Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
14.50 (min)	84.1
16.	112.
20.	216.
25.	410.
30.	664.
35.	954.
40.	1247.
50.	1740.
60.	2017.
70.	2100.
80.	2054.
84.00 (max)	2012.

RMS % Error 9.84

Figure 3.20.3.2.3

Condition/Ht: TEMPER 400F 1HR	
Form: 0.25 in. Plate	Specimen Thk: 0.25 in.
Specimen Type: CNT	Specimen Width: 2 in.
Orientation:	Ao:
Yield Strength: 195 ksi	KIscc:
Ult. Strength:	Ref: 84309

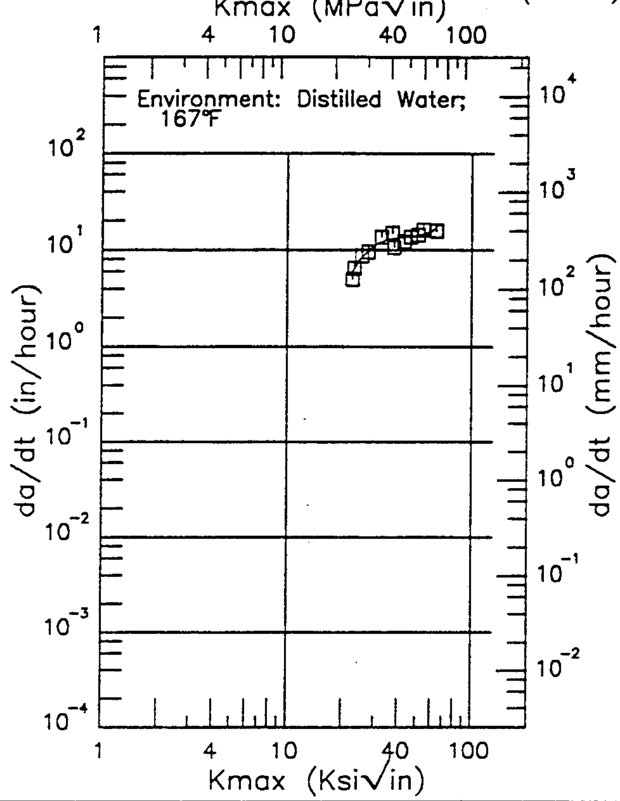
(3 of 7)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
26.00 (min)	2009.
30.	3961.
35.	5371.
40.	5821.
50.	6726.
60.	7564.
70.	7151.
80.00 (max)	7333.

RMS % Error 9.89

(4 of 7)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
22.50 (min)	5804.
25.	8072.
30.	11332.
35.	12816.
40.	13293.
50.	13718.
60.	15332.
64.00 (max)	16594.

RMS % Error 10.02

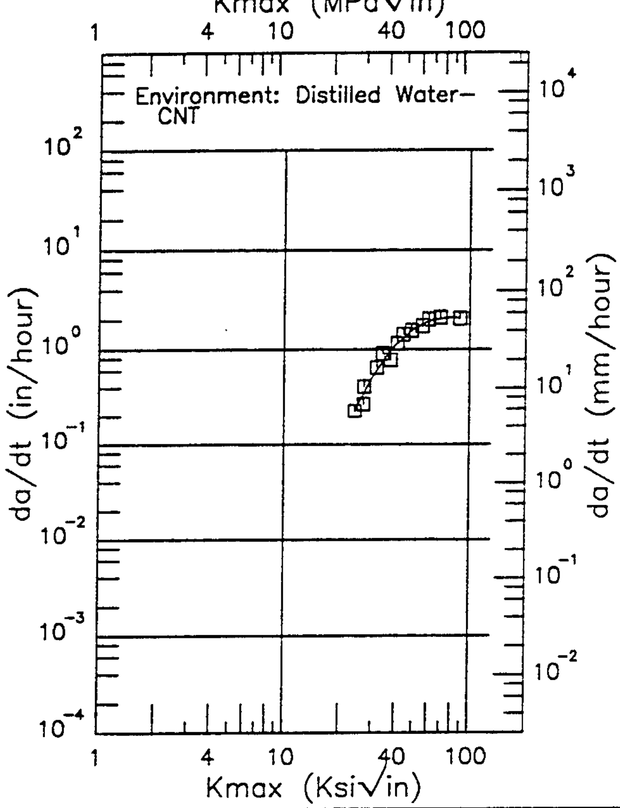
Figure 3.20.3.2.3 (Continued)

4340

Condition/Ht: TEMPER 400F 1HR
Form: 0.25 in. Plate
Specimen Type: CNT
Orientation:
Yield Strength: 195 ksi
Ult. Strength:

Specimen Thk: 0.25 in.
Specimen Width: 2 in.
A_O:
K_{Iscc}:
Ref: 84309

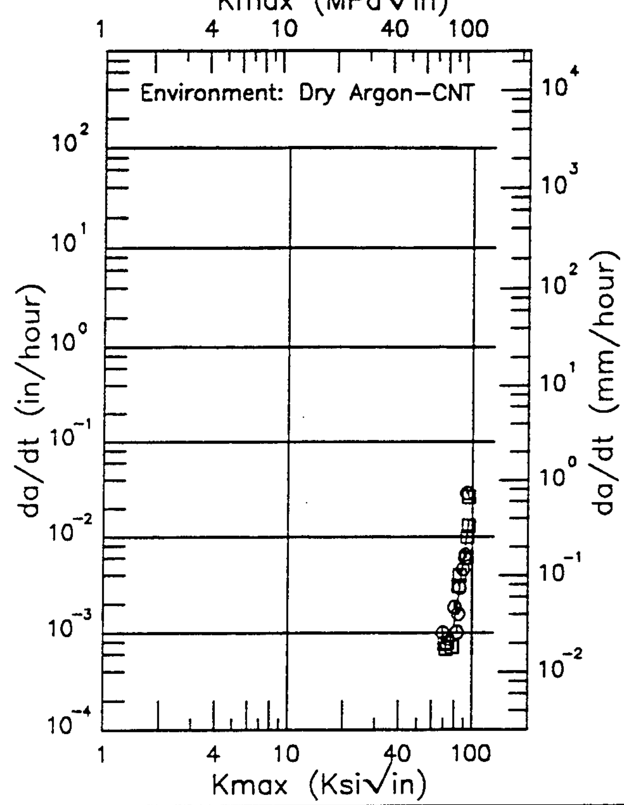
(5 of 7)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
24.00 (min)	224.
25.	266.
30.	521.
35.	817.
40.	1114.
50.	1610.
60.	1923.
70.	2073.
80.	2106.
88.00 (max)	2079.

RMS % Error
11.45

(6 of 7)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
69.00 (min)	0.936
70.	0.834
80.	1.19
90.	5.93
95.30 (max)	14.2

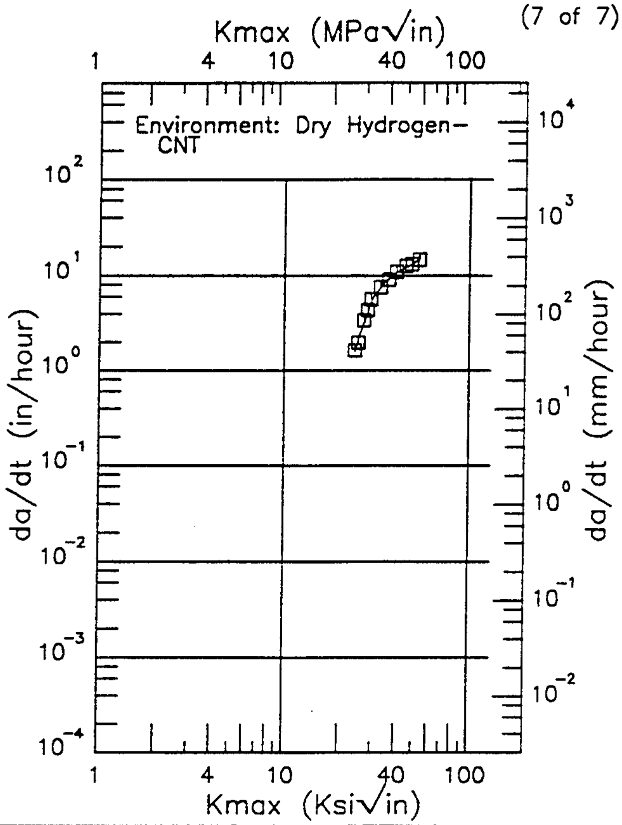
RMS % Error
53.16

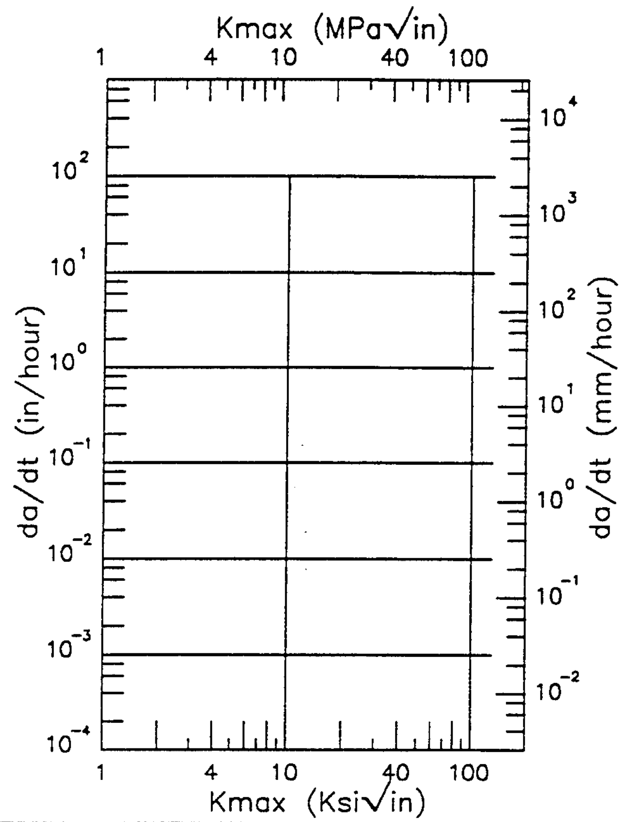
Figure 3.20.3.2.3 (Continued)

Condition/Ht: TEMPER 400F 1HR
Form: 0.25 in. Plate
Specimen Type: CNT
Orientation:
Yield Strength: 195 ksi
Ult. Strength:

Specimen Thk: 0.25 in.
Specimen Width: 2 in.
Ao:
KIscc:
Ref: 84309

(7 of 7)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
24.00 (min)	1579.
25.	2166.
30.	5801.
35.	8872.
40.	10742.
50.	13608.
53.00 (max)	14919.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error 5.4

RMS % Error

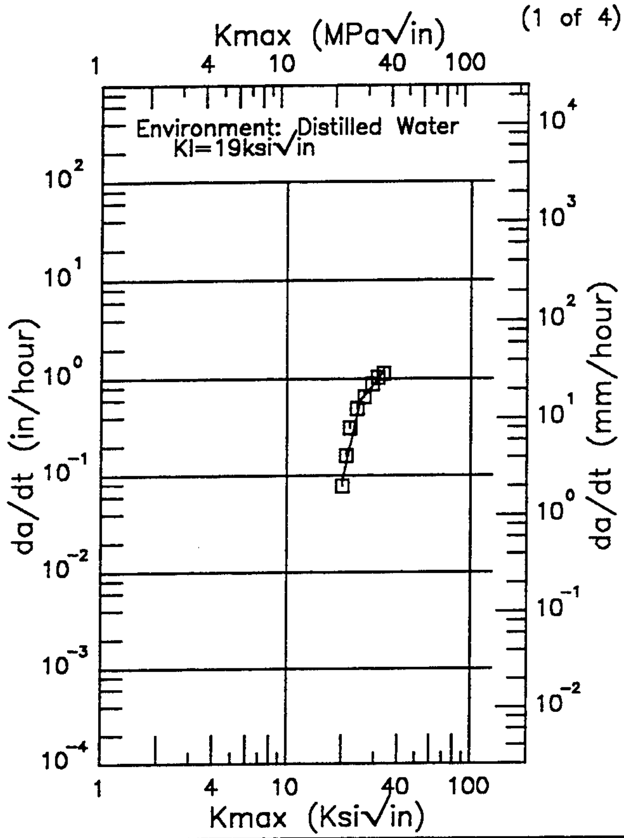
Figure 3.20.3.2.3 (Concluded)

4340

Condition/Ht: TEMPERED 400F
Form:
Specimen Type:
Orientation:
Yield Strength:
Ult. Strength:

Specimen Thk:
Specimen Width:
A_o:
K_{Iscc}:
Ref: 84313;84310

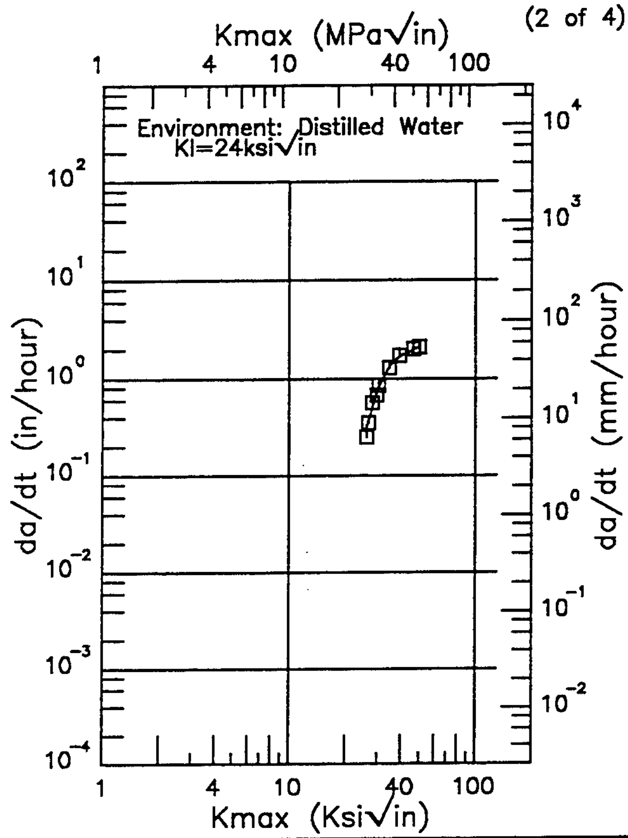
(1 of 4)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
20.00 (min)	83.8
25.	603.
30.	900.
33.30 (max)	1206.

RMS % Error
23.78

(2 of 4)

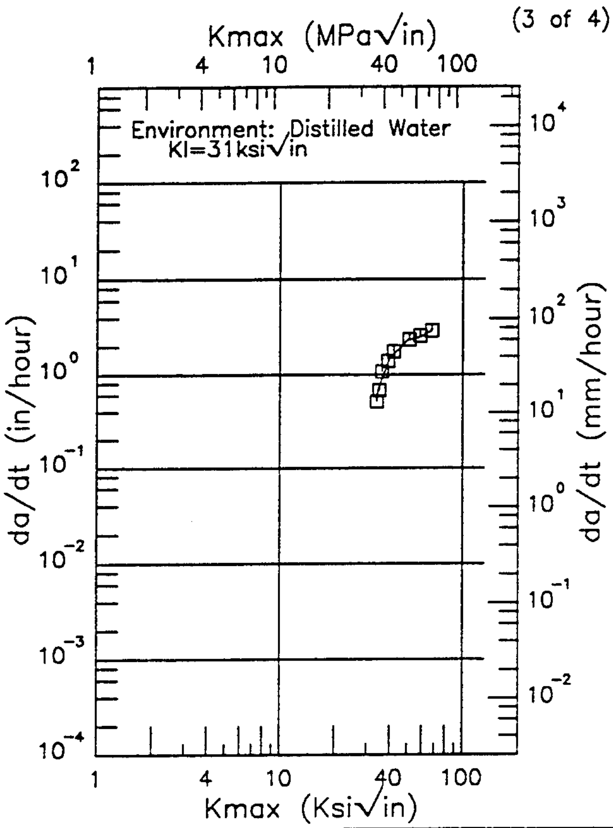


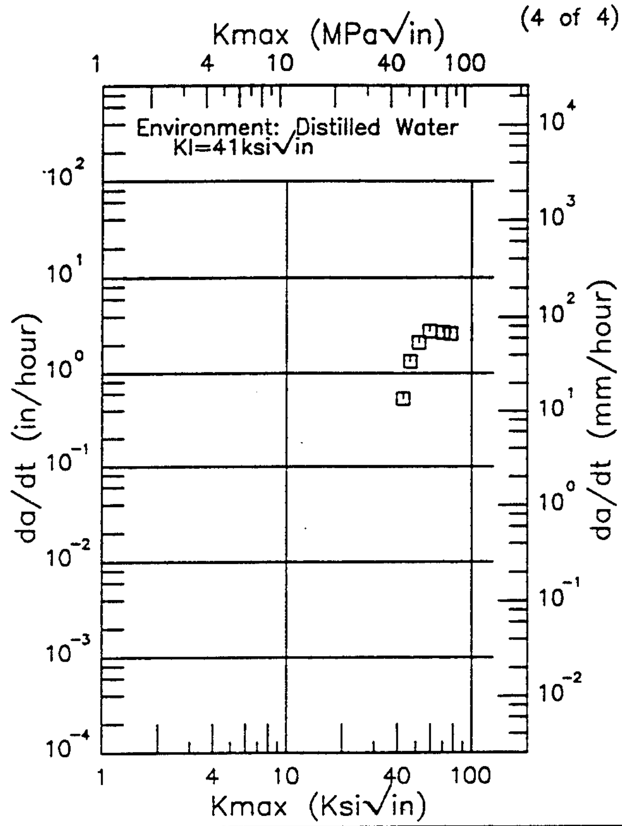
Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
26.00 (min)	300.
30.	787.
35.	1383.
40.	1744.
50.00 (max)	2136.

RMS % Error
7.6

Figure 3.20.3.2.4

Condition/Ht: TEMPERED 400F	
Form:	Specimen Thk:
Specimen Type:	Specimen Width:
Orientation:	A_o:
Yield Strength:	K_{Iscc}:
Ult. Strength:	Ref: 84313;84310





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
33.80 (min)	579.
35.	756.
40.	1533.
50.	2341.
60.	2553.
67.50 (max)	2932.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error 9.92

RMS % Error

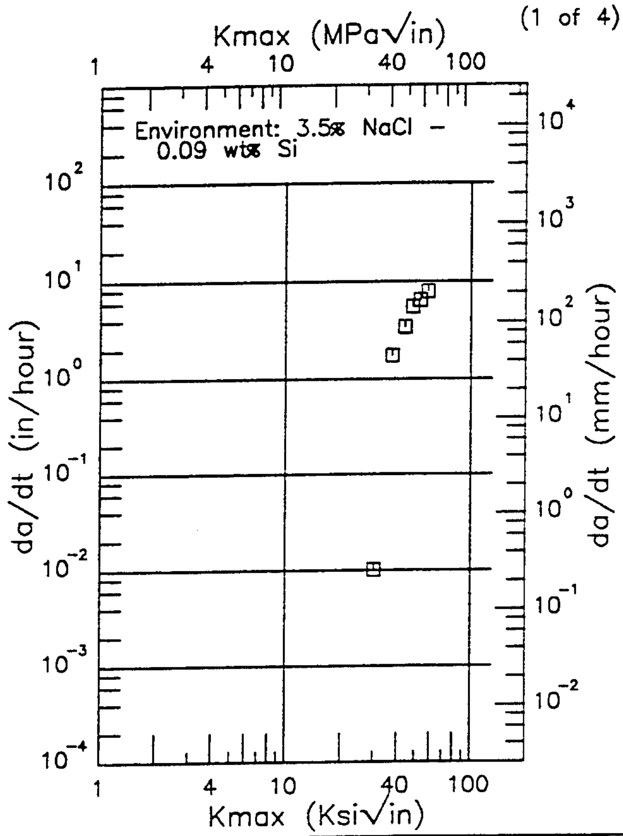
Figure 3.20.3.2.4 (Concluded)

4340

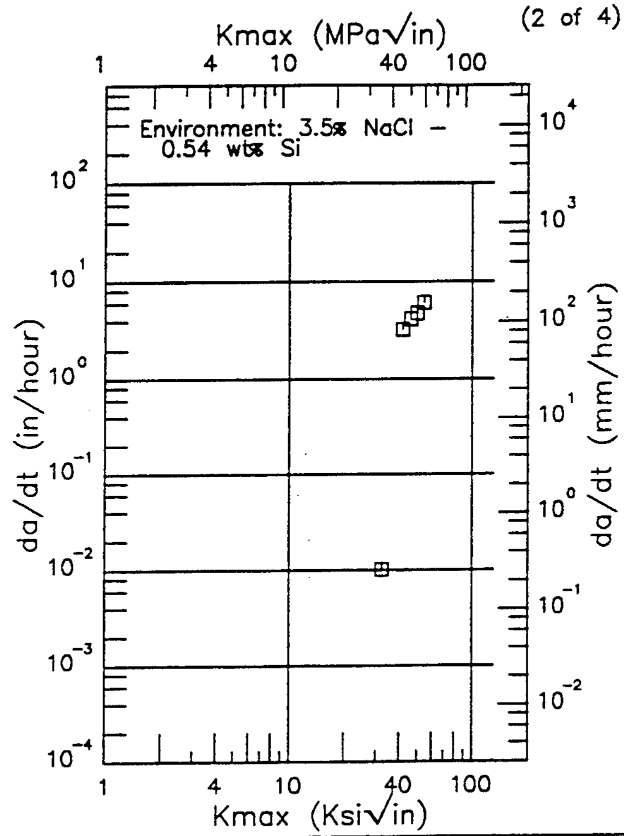
Condition/Ht: TYS=200-240KSI
Form: 1.5 in. Extrusion
Specimen Type: NB - 3 pt
Orientation: L-S
Yield Strength: 202 - 240 ksi
Ult. Strength:

Specimen Thk: 0.48 in.
Specimen Width: 1.5 in.
Ao:
K_{Iscc}: 13 - 16 ksi
Ref: 74718

(1 of 4)



(2 of 4)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)	Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

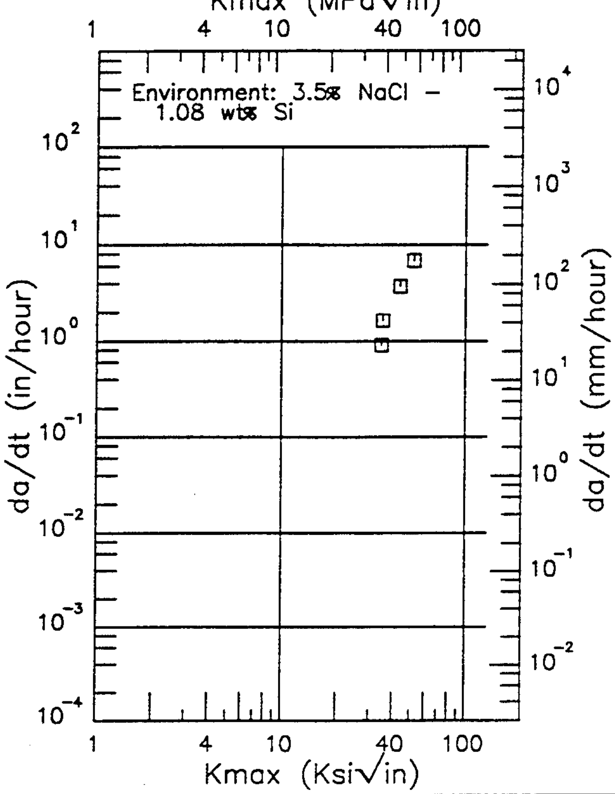
RMS % Error		RMS % Error	

Figure 3.20.3.2.5

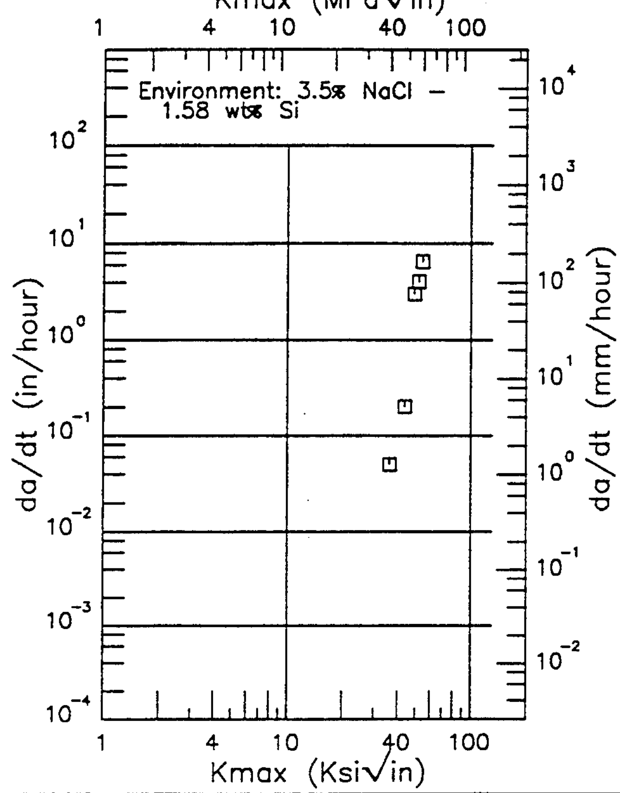
Condition/Ht: TYS=200-240KSI
Form: 1.5 in. Extrusion
Specimen Type: NB - 3 pt
Orientation: L-S
Yield Strength: 202 - 240 ksi
Ult. Strength:

Specimen Thk: 0.48 in.
Specimen Width: 1.5 in.
A_o:
K_{Iscc}: 13 - 16 ksi
Ref: 74718

(3 of 4)



(4 of 4)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error	

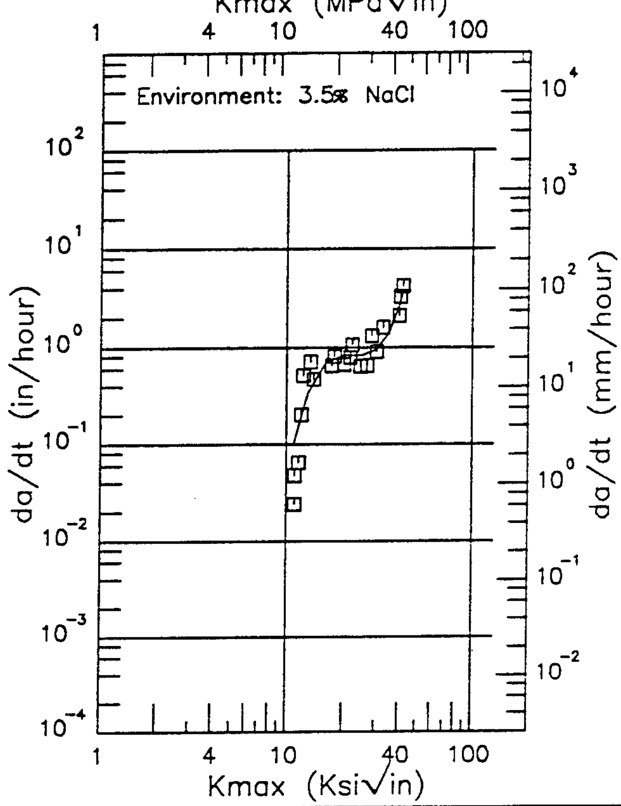
RMS % Error	

Figure 3.20.3.2.5 (Concluded)

4340

Condition/Ht: TYS=220KSI	
Form: 12 in. Forging	Specimen Thk: 0.502 in.
Specimen Type: SENT	Specimen Width: 3 in.
Orientation:	Ao:
Yield Strength: 220 ksi	K_{Iscc}: 10 ksi
Ult. Strength:	Ref: 81814

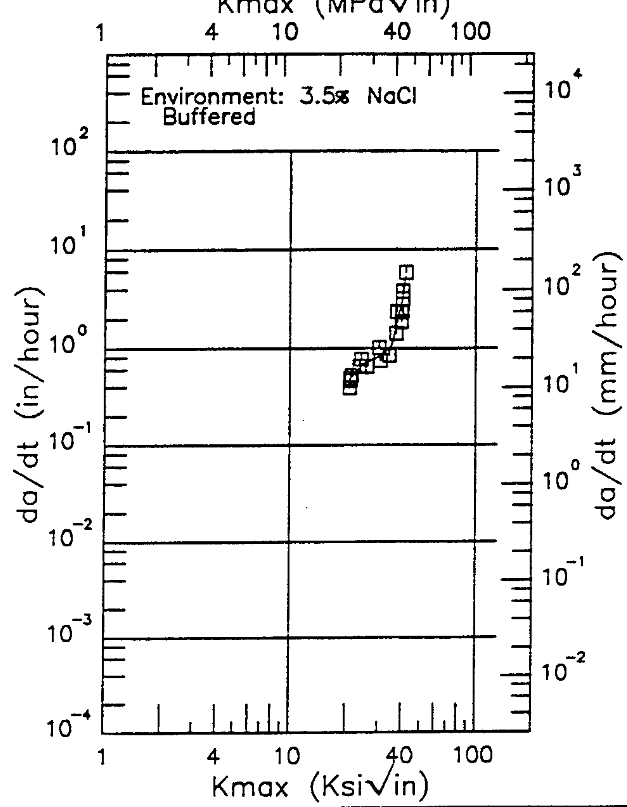
(1 of 2)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
11.00 (min)	107.
13.	342.
16.	690.
20.	832.
25.	829.
30.	952.
35.	1410.
40.	2717.
42.00 (max)	3782.

RMS % Error 47.28

(2 of 2)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
20.80 (min)	477.
25.	699.
30.	817.
35.	1046.
40.	3055.
41.50 (max)	5362.

RMS % Error 17.93

Figure 3.20.3.2.6

TABLE 3.20.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 4340

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
Unspecified	S	R.T.	---	---	3.5% NaCl	CNT	---	---	---	---	80	10	---	1968	84290
						PTSC	---	---	---	---	67	10	---	1968	84290
	P	R.T.	L-T	---	3.5% NaCl	CANT	---	---	---	---	57	10	---	1968	84290
Unspecified	F	R.T.	---	200	Dist Water	CANT*	0.394	0.394	0.4	---	88	45	48800	1969	76972
1350°F OQ; 750°F 1.25hr	P	R.T.	T-S	194	3.5% NaCl	CANT	1	0.4	1	---	72.2	8.5	20000	1970	78761
1550°F OQ; 750°F Crack Prestressed to 80% KIC	P	R.T.	---	194.2	3.5% NaCl	NB*	1	0.5	1	---	72.2	24	20000	1972	84356
1550°F OQ; 750°F Crack Prestressed to 60% KIC	P	R.T.	---	194.2	3.5% NaCl	NB*	1	0.5	1	---	72.2	23	20000	1972	84356
1550°F OQ; 750°F 1hr Crack Prestressed to 20% KIC	P	R.T.	---	194.2	3.5% NaCl	NB*	1	0.5	1	---	72.2	8	20000	1972	84356
1550°F OQ; 750°F Crack Prestressed to 40% KIC	P	R.T.	---	194.2	3.5% NaCl	NB*	1	0.5	1	---	72.2	17	20000	1972	84356
1550°F OQ; 750°F Crack Prestressed to 20% KIC	P	R.T.	---	194.2	3.5% NaCl	NB*	1	0.5	1	---	72.2	12	20000	1972	84356
1575°F OQ; 675°F 4hr	P	R.T.	---	209.6	Dist Water	CANT*	0.665	0.25	0.75	0.13	48.8	9.8	7500	1965	63061

TABLE 3.20.3.3 (CONTINUED)

K_{Iscc} SUMMARY FOR ALLOY STEEL 4340

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1575°F OQ; 800°F 4hr	P	R.T.	---	222.4	Dist Water	CANT*	0.665	0.25	0.75	0.13	48.6	9.8	2640	1965	63061
1600°F 1hr OQ; 600°F 1+1hr	F	R.T.	---	220	3.5% NaCl	SENT	3	0.502	12	0.8	---	10	---	1971	81814
1625°F Q; 1525°F OQ; 400°F 2+2hr; 1625°F Q; 1525°F OQ	F	R.T.	---	212.2	Air 90% PH	PTSC	1.5	0.48	8	0.14	63	27	---	1965	74718
				220.8	Air 90% PH	PTSC	1.5	0.48	8	0.14	63.6	57	1200	1965	74718
1650°F 1hr AC; 1680°F 2hr OQ; LN 0.25hr; 400°F 1+1hr OQ	B	R.T.	L-T	245	3.5% NaCl	CANT*	1.45	0.575	1.5	---	51	15	3500	1969	75025
1650°F 1hr AC; 1480°F 2hr OQ; LN 0.25hr; 400°F 1+1hr OQ	B	R.T.	L-T	249	3.5% NaCl	CANT*	1.45	0.575	1.5	---	51	15	1800	1969	75025
1700°F 0.25hr AC; 1550°F OQ; 600°F 1+1hr	S	R.T.	---	206	3.5% NaCl	CNT	2	0.05	0.08	---	---	29	1000	1968	72283
					Dist Water	CNT	2	0.05	0.08	---	---	29	1000	1968	72283
1800°F Q; 600°F 1+1hr	F	R.T.	L-S	210	3.5% NaCl	CANT	1	1	1	---	82	25	---	1971	80423
						CANT	---	1	1	---	82	30	---	1971	80423
						CANT	1	1	1	---	78	22	---	1971	80423
						CANT	1	1	1	---	78	24	---	1971	80423

TABLE 3.20.3.3 (CONCLUDED)

K_{Iscc} SUMMARY FOR ALLOY STEEL 4340

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
1800°F Q; 600°F 1+1hr (cont'd)	F (cont'd)	R.T. (cont'd)	L-S (cont'd)	210 (cont'd)	3.5% NaCl (cont'd)	CANT	1	1	1	---	78	23	---	1971	80423
						CANT	1	1	1	---	78	24	---	1971	80423
						CANT	1	1	1	---	78	25	---	1971	80423
						CANT	1	1	1	---	82	25	---	1971	80423
						CANT	1	1	1	---	82	24	---	1971	80423
						CANT	1	1	1	---	78	26	---	1971	80423
						CANT	1	1	1	---	82	31	---	1971	80423
						CANT	1	1	1	---	82	23	---	1971	80423
TYS=125KSI	P	R.T.	T-L	125	Seawater	CANT	---	---	---	---	89	70+	---	1967	70887
TYS=150KSI	P	R.T.	T-L	150	Seawater	CANT	---	---	---	---	85	59	---	1967	70887
TYS=175KSI	P	R.T.	T-L	175	Seawater	CANT	---	---	---	---	75	27	---	1967	70887
TYS=200KSI	P	R.T.	T-L	200	Seawater	CANT	---	---	---	---	59	10	---	1967	70887
TYS=225KSI	P	R.T.	T-L	225	Seawater	CANT	---	---	---	---	63	5	1200	1967	70887

+ crack length and/or specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.21.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS
FOR ALLOY STEEL 4340 (AM) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} ($ksi\sqrt{in}$)								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	40.5	0.5	3	---	---	---	---	---	---

TABLE 3.21.2.1

ALLOY STEEL 4340 (AM) K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}: K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic}: K_{Ic} MEAN	K_{Ic}: STAN DEV	DATE	REFER
1600F 1 HR AC 1550F 1 HR OQ -320F 0.5 HR 400F 2 HR AC	Forging	4.00	R.T.	L-T	241.0	1.800	0.900	NB	---	0.07	41.00	40.5	0.5	1968	73300
		4.00			241.0	1.800	0.900	NB	---	0.07	40.60			1968	73300
		4.00			241.0	1.800	0.900	NB	---	0.07	40.00			1968	73300

TABLE 3.22.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 4340 (DH) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	51	3.	7	---	---	---	---	---	---
Billet	1550F OQ 900F 1HR	---	---	---	66.3	6.2	4	---	---	---

TABLE 3.22.2.1

ALLOY STEEL 4340 (DH) K_{Ic}

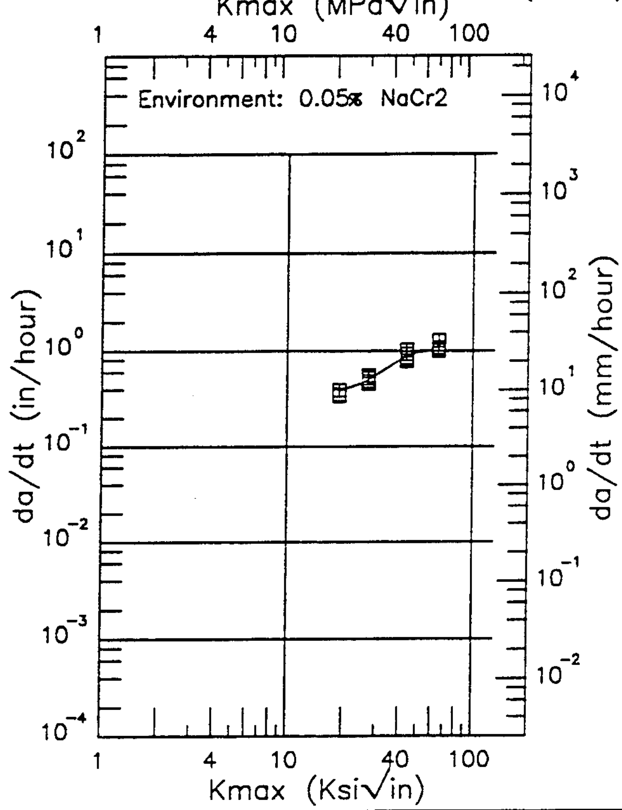
CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1550F OQ 900F 1HR	Billet	1.00	-100	L-T	---	2.000	1.000	CT	1.023	---	88.00	98.5	9.3	1970	84280
		1.00			---	2.000	1.000	CT	1.030	---	103.00			1970	84280
		1.00			---	2.000	1.000	CT	1.030	---	109.00			1970	84280
		1.00			---	2.000	1.000	CT	1.026	---	94.00			1970	84280
1550F OQ 900F 1HR	Billet	1.00	-77	L-T	---	2.000	1.000	CT	1.045	---	107.00	---	---	1970	84280
1550F OQ 900F 1HR	Billet	1.00	-60	T-L	---	2.000	1.000	CT	1.015	---	62.00	60.3	2.9	1970	84280
		1.00			---	2.000	1.000	CT	1.000	---	62.00			1970	84280
		1.00			---	2.000	1.000	CT	1.005	---	57.00			1970	84280
1550F OQ 900F 1HR	Billet	1.00	R.T.	T-L	---	2.000	1.000	CT	1.000	---	75.00	66.3	6.2	1970	84280
		1.00			---	2.000	1.000	CT	1.025	---	66.00			1970	84280
		1.00			---	2.000	1.000	CT	1.010	---	63.00			1970	84280
		1.00			---	2.000	1.000	CT	1.020	---	61.00			1970	84280
1600F 1 HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	4.00	R.T.	L-T	229.0	1.800	0.900	NB	---	0.12	51.10	51.0	3.0	1968	73300
		4.00			229.0	1.800	0.900	NB	---	0.14	54.30			1968	73300
		4.00			229.0	1.800	0.900	NB	---	0.15	55.30			1968	73300
		4.00			229.0	1.800	0.900	NB	---	0.12	51.30			1968	73300
		4.00			231.0	1.800	0.900	NB	---	0.12	49.70			1968	73300
		4.00			231.0	1.800	0.900	NB	---	0.10	46.90			1968	73300
		4.00			231.0	1.800	0.900	NB	---	0.11	48.40			1968	73300
1600F 1 HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	Forging	4.00	R.T.	T-S	233.0	1.800	0.900	NB	---	0.13	52.50	52.5	0.0	1968	73300
		4.00			233.0	1.800	0.900	NB	---	0.13	52.50			1968	73300
		4.00			233.0	1.800	0.900	NB	---	0.13	52.50			1968	73300

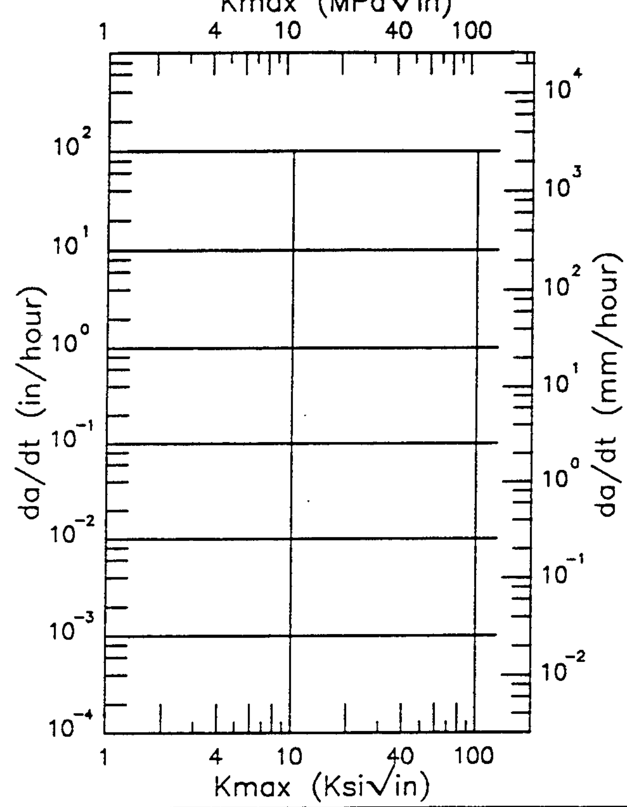
4340 (EFM)

Condition/Ht: 1550F .5HR 400F 4HR
Form: 0.5 in. Plate
Specimen Type: TDCB
Orientation: T-L
Yield Strength: 240 ksi
Ult. Strength:

Specimen Thk: 0.3 in.
Specimen Width: 6 in.
Ao:
KIscc:
Ref: 83611

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
19.00 (min)	390.
20.	396.
25.	464.
30.	568.
35.	686.
40.	800.
50.	968.
60.	1013.
65.00 (max)	990.

Kmax (Ksi√in) da/dt (10^{-3}in/hour)

RMS % Error
10.81

RMS % Error

Figure 3.23.3.2

TABLE 3.24.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL 4340(MOD)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
1650°F 1hr; 1600°F 1hr OQ 1+1 600°F (0.09 SI)	B	R.T.	T-L	201.8	3.5% NaCl	CANT	1.5	0.48	1.5	---	73	13	5000	1965	74718
				204.2	3.5% NaCl	CANT	1.5	0.48	1.5	---	78	18	5000	1965	74718
1800°F Q; 460°F 1+1hr (0.20C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	87	56	---	1971	80423
1800°F Q; 500°F 1+1hr (0.21C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	87	52	---	1971	80423
1800°F Q; 600°F 1hr (0.20C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	98	72	---	1971	80423
1800°F Q; 650°F 1hr (0.24C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	92	62	---	1971	80423
1800°F Q; 650°F 1+1hr (0.28C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	87	35	---	1971	80423
1800°F Q; 700°F 1hr (0.21C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	85	42	---	1971	80423
1800°F Q; 780°F 1+1hr (0.33C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	87	32	---	1971	80423
1800°F Q; 800°F 1hr (0.46C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	78	20	---	1971	80423
1800°F Q; 900°F 1hr (0.64C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	65	30	---	1971	80423
1800°F Q; 925°F 1+1hr (0.53C)	F	R.T.	L-S	195	3.5% NaCl	CANT	1	1	1	---	87	42	---	1971	80423

TABLE 3.25.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL 4340 (VAR) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1600F 1HR AC 1550F 1HR OQ -320F 0.5HR 400F 2HR AC	55.	4.4	8	---	---	---	---	---	---

TABLE 3.25.2.1

ALLOY STEEL 4340 (VAR) K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV		
1600F 1 HR AC 1550F 1 HR OQ -320F 0.5 HR 400F 2 HR AC	Forging	4.00	R.T.	L-T	240.0	1.800	0.900	NB	---	0.13	55.00	55.0	4.4	1968	73300 (1)
		4.00			240.0	1.800	0.900	NB	---	0.16	61.30			1968	73300 (1)
		4.00			240.0	1.800	0.900	NB	---	0.12	51.80			1968	73300 (1)
		4.00			240.0	1.800	0.900	NB	---	0.15	59.20			1968	73300 (1)
		4.00			241.0	1.800	0.900	NB	---	0.10	48.60			1968	73300
		4.00			241.0	1.800	0.900	NB	---	0.13	54.60			1968	73300
		4.00			241.0	1.800	0.900	NB	---	0.11	51.10			1968	73300
		4.00			241.0	1.800	0.900	NB	---	0.15	58.60			1968	73300

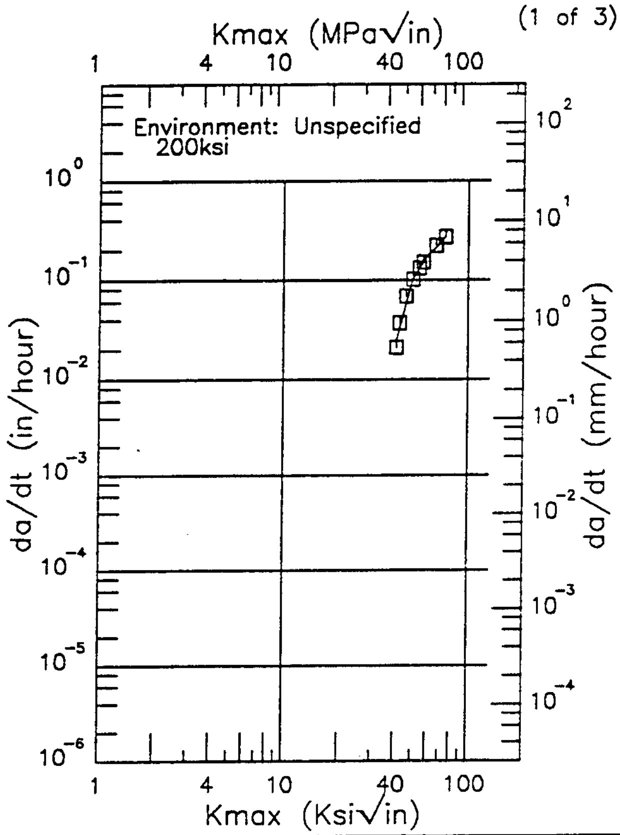
NOTES: (1) COMPOSITION (WT PERCENT) 0.42C, 0.81Mn, 0.008P, 0.004S, 0.36Si, 1.63Ni, 0.84Cr, 0.22Mo, 0.001Al, 0.002Ca, 0.0022N

4340V

Condition/Ht:
Form: 0.4 in. Extrusion
Specimen Type: CB
Orientation:
Yield Strength: 142 – 200 ksi
Ult. Strength:

Specimen Thk: 0.394 in.
Specimen Width: 0.394 in.
A_O:
K_{Iscc}: 45 – 103 ksi
Ref: 76972

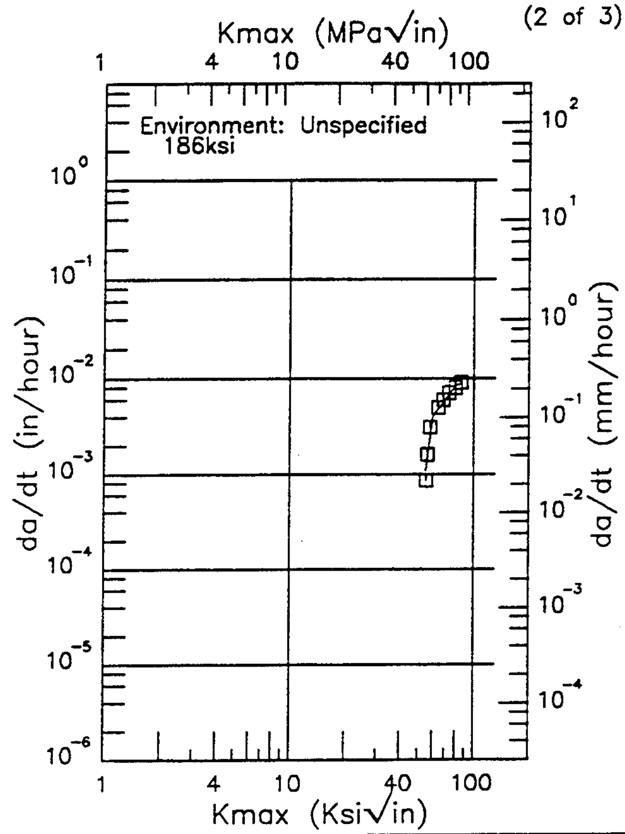
(1 of 3)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
41.00 (min)	25.3
50.	101.
60.	174.
70.	235.
75.00 (max)	279.

RMS % Error
11.09

(2 of 3)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
55.00 (min)	1.09
60.	4.05
70.	5.97
80.	8.46
85.00 (max)	8.78

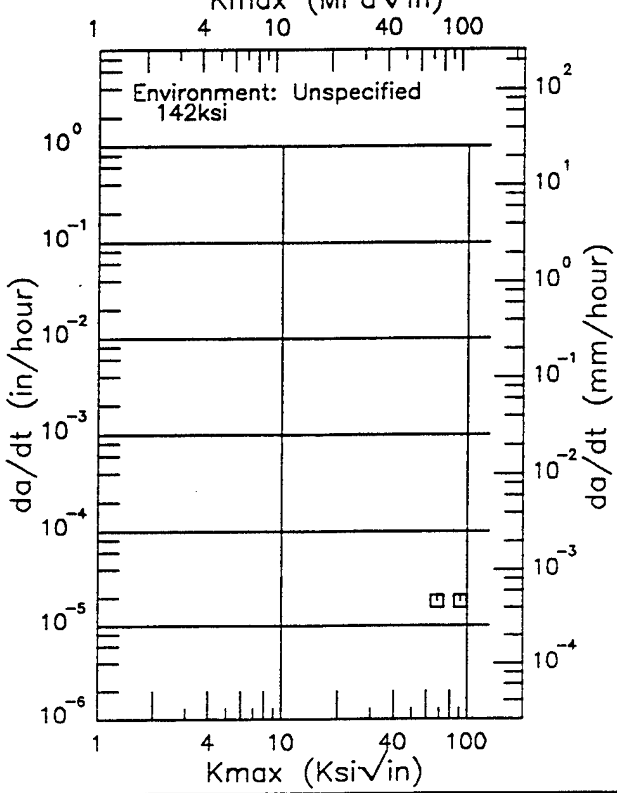
RMS % Error
13.74

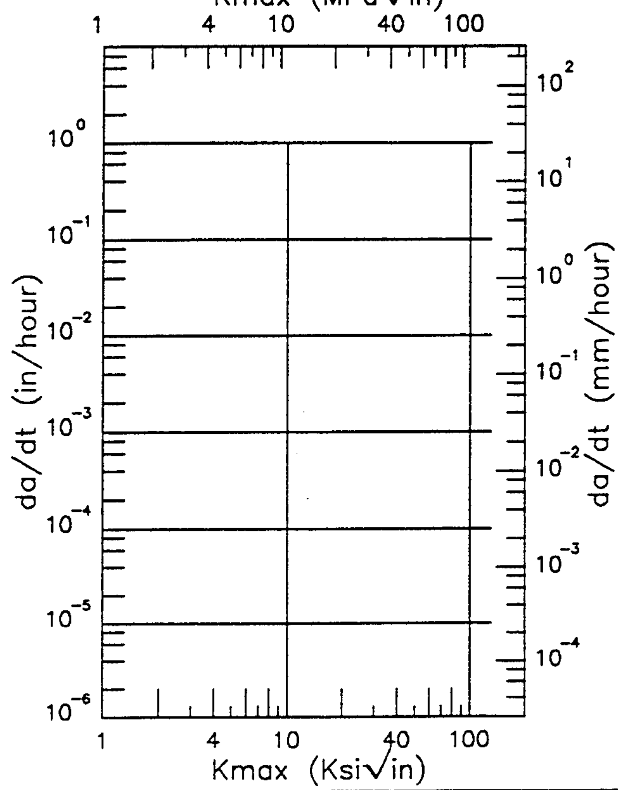
Figure 3.26.3.2

Condition/Ht:
Form: 0.4 in. Extrusion
Specimen Type: CB
Orientation:
Yield Strength: 142 – 200 ksi
Ult. Strength:

Specimen Thk: 0.394 in.
Specimen Width: 0.394 in.
A_O:
K_{Iscc}: 45 – 103 ksi
Ref: 76972

(3 of 3)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)	Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error		RMS % Error	

Figure 3.26.3.2 (Concluded)

TABLE 3.27.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK A286 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
1800F 0.5-1.0 HR WQ 1325F 16HR AC	PLATE	0.05	3				1.59	31.48	

TABLE 3.27.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK A286 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1800F 0.5-1.0 HR WQ 1325F 16HR AC	PLATE	0.05	3				1.82		

A286

EF

Condition/Ht: 1800F 0.5–1.0 HR WQ 1325F 16HR AC

Form: 0.5 in. Plate

Specimen Type: CT

Orientation: L–T

Stress Ratio: 0.05

Yield Strength: 100 ksi

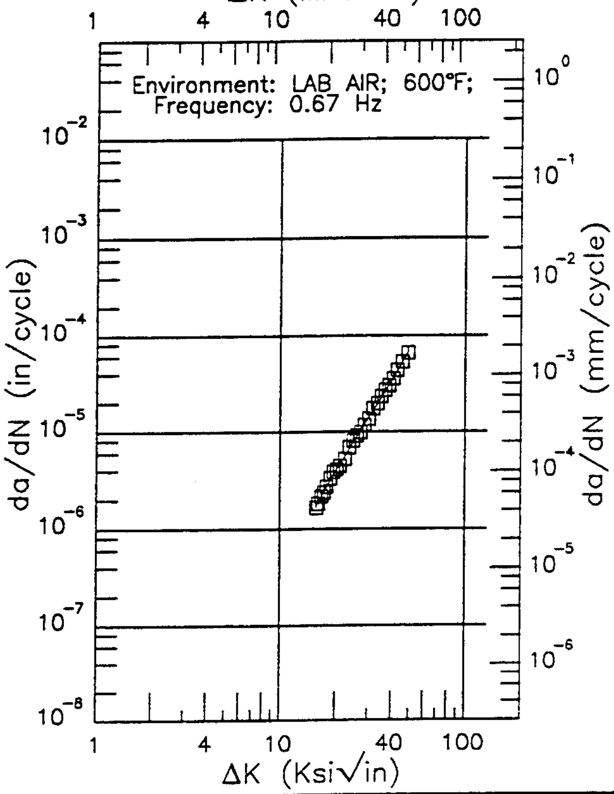
Ult. Strength: 159.5 ksi

Specimen Thk: 0.484 – 0.487 in.

Specimen Width: 1.997 – 2.001 in.

Ref: HD006

(1 of 4)

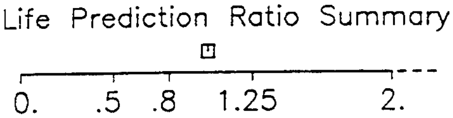


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.66 (min)	1.70
16.	1.84
20.	3.94
25.	7.96
30.	13.9
35.	22.2
40.	33.8
48.91 (max)	66.5

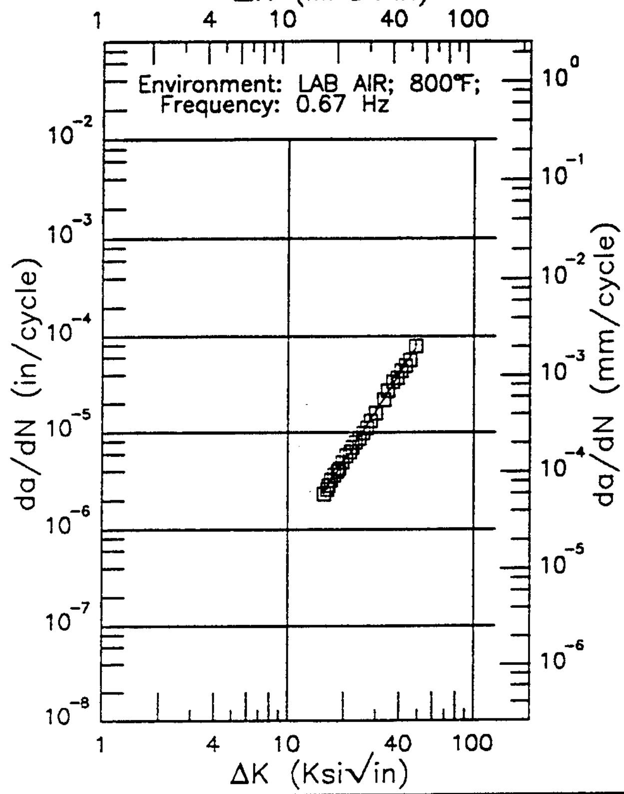
RMS % Error

3.33

Life Prediction Ratio Summary



(2 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.62 (min)	2.39
16.	2.57
20.	5.01
25.	9.68
30.	16.7
35.	26.6
40.	40.1
48.76 (max)	75.7

RMS % Error

3.54

Life Prediction Ratio Summary

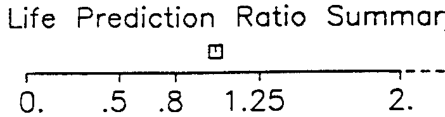
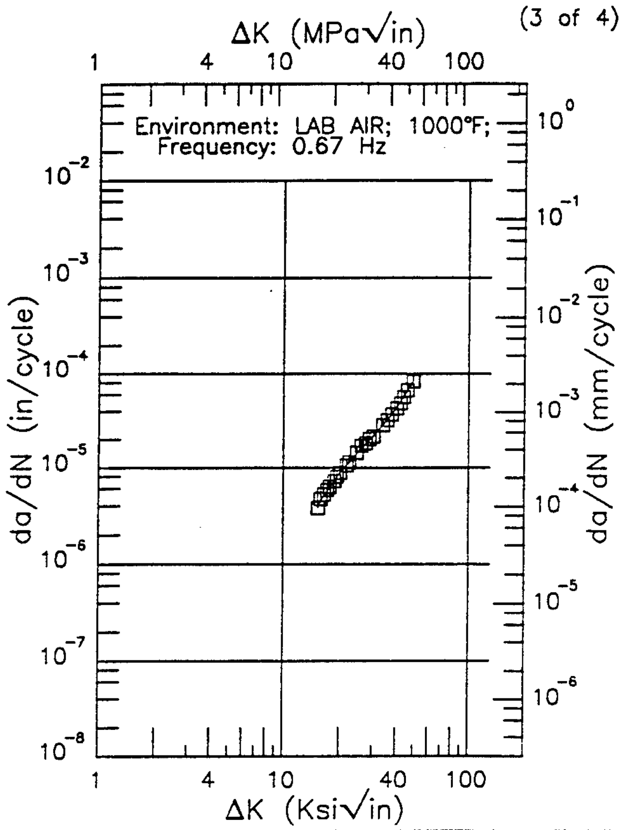


Figure 3.27.3.1.1

Condition/Ht: 1800F 0.5–1.0 HR WQ 1325F 16HR AC
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.05

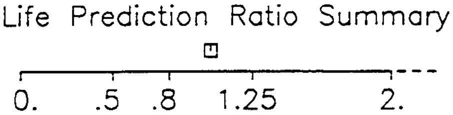
Yield Strength: 100 ksi
Ult. Strength: 159.5 ksi
Specimen Thk: 0.484 – 0.487 in.
Specimen Width: 1.997 – 2.001 in.
Ref: HD006

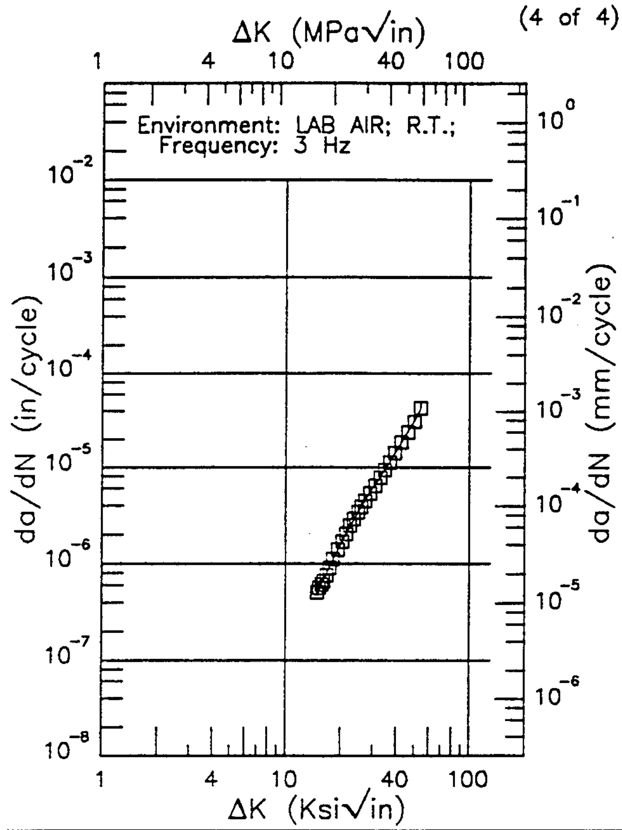


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.26 (min)	3.96
16.	4.66
20.	8.86
25.	14.7
30.	21.6
35.	30.5
40.	42.8
49.18 (max)	82.1

RMS % Error: 2.40

Life Prediction Ratio Summary





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.92 (min)	0.474
16.	0.650
20.	1.59
25.	3.43
30.	6.09
35.	9.79
40.	14.9
50.	31.5
53.83 (max)	41.2

RMS % Error: 3.00

Life Prediction Ratio Summary

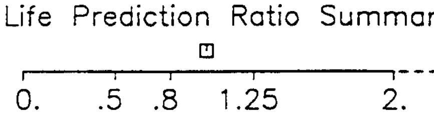


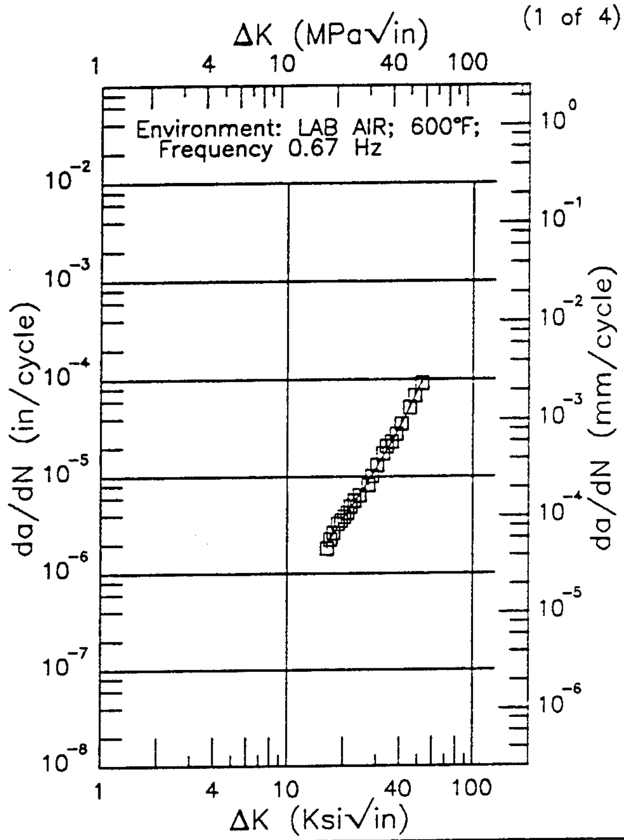
Figure 3.27.3.1.1 (Concluded)

EF A286

Condition/Ht: 1800F 0.5–1.0 HR WQ 1325F 16HR AC
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.05

Yield Strength: 100 ksi
Ult. Strength: 159.5 ksi
Specimen Thk: 0.486 – 0.488 in.
Specimen Width: 1.999 – 2.002 in.
Ref: HD006

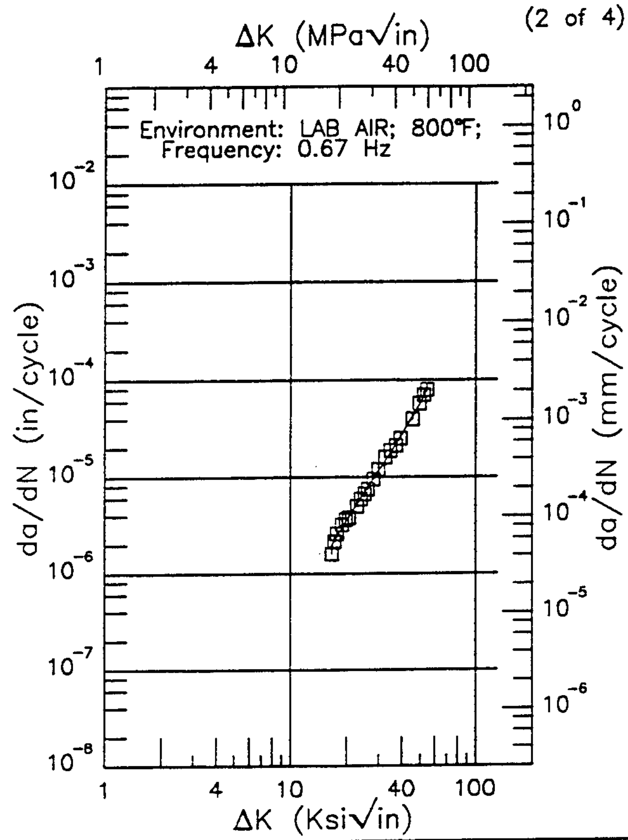
(1 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.25 (min)	2.02
20.	3.69
25.	7.06
30.	12.3
35.	20.3
40.	32.3
50.	76.6
52.49 (max)	94.0

RMS % Error	Life Prediction Ratio Summary
5.12	0. .5 .8 1.25 2.

(2 of 4)



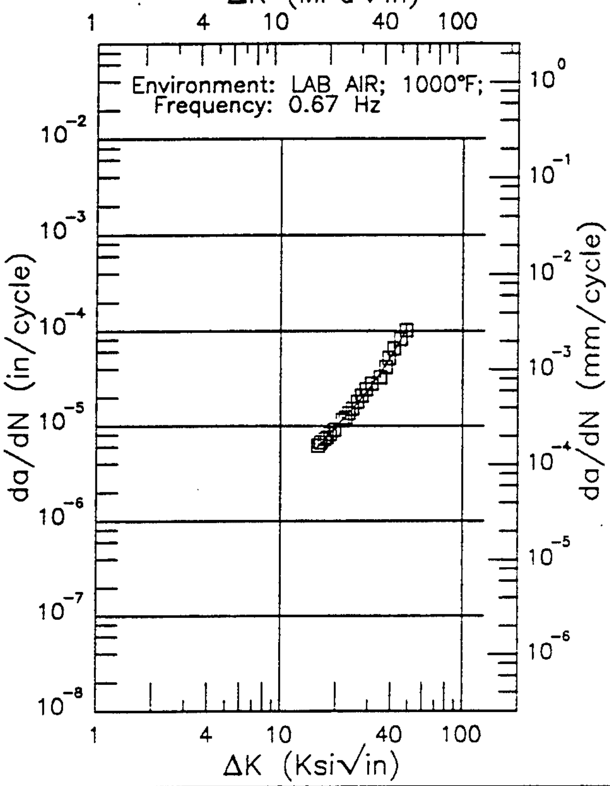
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.59 (min)	1.93
20.	3.54
25.	6.89
30.	11.7
35.	18.3
40.	27.5
50.	57.6
54.51 (max)	78.9

RMS % Error	Life Prediction Ratio Summary
6.02	0. .5 .8 1.25 2.

Figure 3.27.3.1.2

Condition/Ht: 1800F 0.5–1.0 HR WQ 1325F 16HR AC
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.05
Yield Strength: 100 ksi
Ult. Strength: 159.5 ksi
Specimen Thk: 0.486 – 0.488 in.
Specimen Width: 1.999 – 2.002 in.
Ref: HD006

(3 of 4)



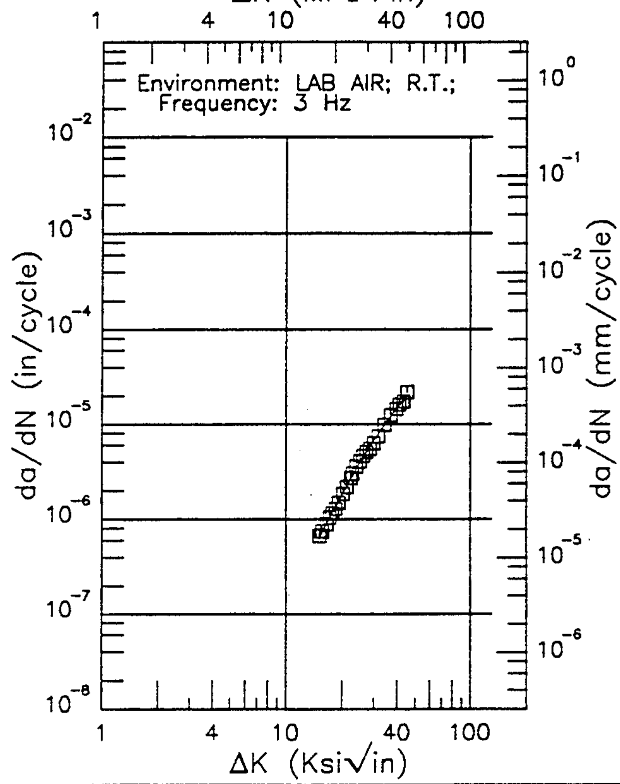
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.89 (min)	6.04
16.	6.12
20.	9.69
25.	15.7
30.	24.1
35.	36.2
40.	53.5
48.72 (max)	104.

RMS % Error 3.93

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(4 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.19 (min)	0.638
16.	0.786
20.	1.82
25.	3.86
30.	6.76
35.	10.5
40.	15.0
45.10 (max)	20.4

RMS % Error 4.06

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

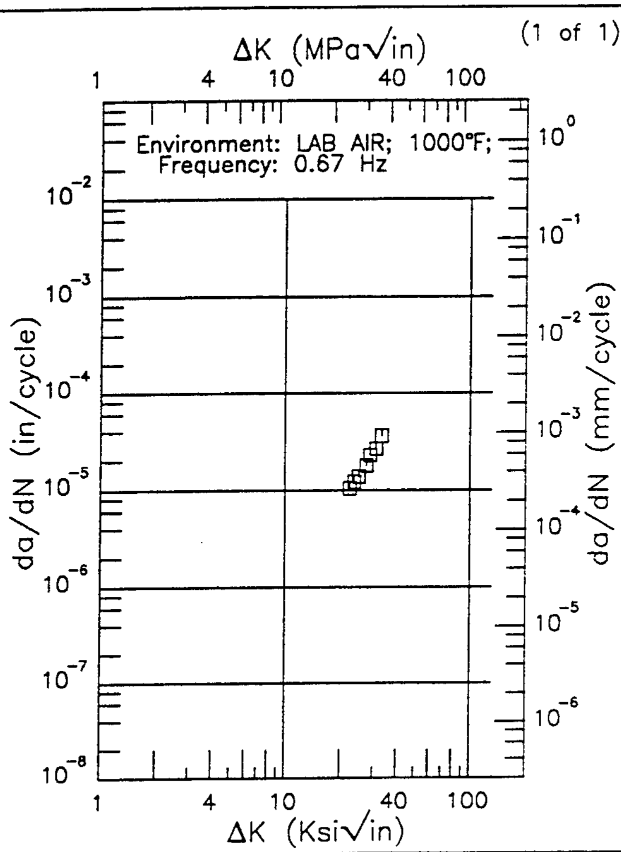
Figure 3.27.3.1.2 (Concluded)

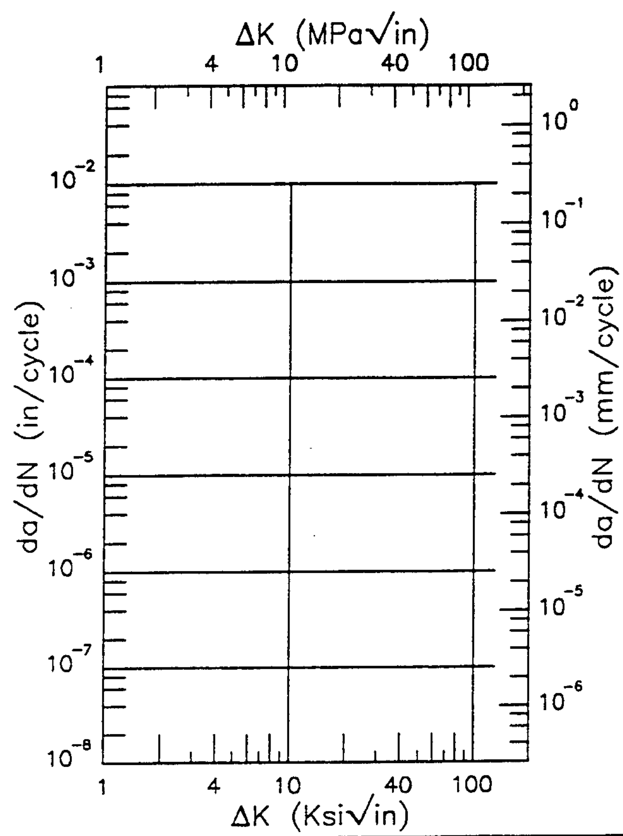
EF A286

Condition/Ht: 1800F 0.5–1.0 HR WQ 1325F 16HR AC
Form: 1.5 in. Round Bar
Specimen Type: CT
Orientation: R–L
Stress Ratio: 0.05

Yield Strength: 136.4 ksi
Ult. Strength: 168.3 ksi
Specimen Thk: 0.29 in.
Specimen Width: 1.153 in.
Ref: HD006

(1 of 1)





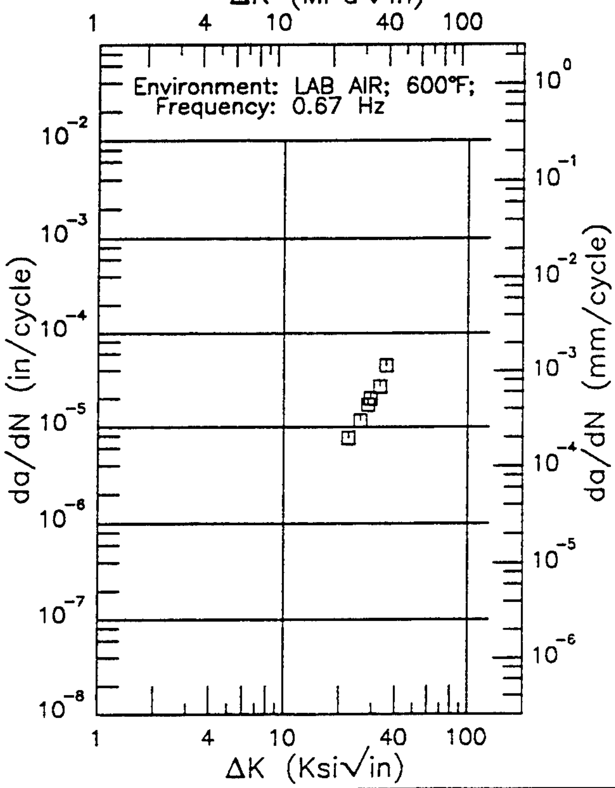
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

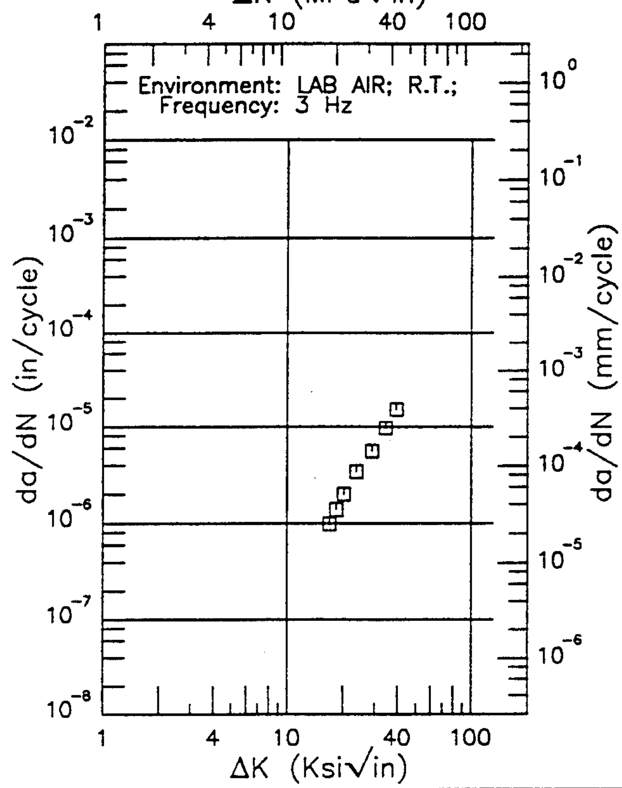
RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.27.3.1.3

Condition/Ht: 1800F 0.5–1.0 HR WQ 1325F 16HR AC
Form: 1.5 in. Round Bar
Specimen Type: CT
Orientation: R–C
Stress Ratio: 0.05

Yield Strength: 136.4 ksi
Ult. Strength: 168.3 ksi
Specimen Thk: 0.401 – 0.403 in.
Specimen Width: 0.795 – 0.804 in.
Ref: HD006





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.27.3.1.4

TABLE 3.28.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS
FOR ALLOY STEEL AF 1410 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$ Specimen Orientation L-T Mean K_{Ic}	L-T Std Dev	L-T n	T-L Mean K_{Ic}	T-L Std Dev	T-L n	S-L Mean K_{Ic}	S-L Std Dev	S-L n
Plate	1650F 1HR WQ 1500F 1HR WQ 950F 5HR AC	139.6	11.7	2	136.7	7.4	2	---	---	---
Forging	Unspecified	98.7	11.3	6	105.6	4.8	3	---	---	---

TABLE 3.28.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK AF1410 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1525F 1HR AC -100F 1HR AC 950F 5HRS AC	ROUND BAR	0.02	0.1-30		0.11	0.64	3.6	32.69	151.39

TABLE 3.28.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK AF1410 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
1525F 1HR AC -100F 1HR AC 950F 5HRS AC	ROUND BAR	0.02	0.1-30		0.11	0.68	3.64	31.7	172.61

TABLE 3.28.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK AF1410 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
AIR QUENCHED	PLATE	0.08	10-30				4.2	37.13	
OIL QUENCHED	PLATE	0.08	1-30				4.4	31	

TABLE 3.28.2.1

ALLOY STEEL AF 1410 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_Q/TYS)^2$ (in.)	K_{Ic}: K_Q (Ksi $\cdot \sqrt{in.}$)	K_{Ic}: K_Q MEAN	K_{Ic}: STAN DEV	DATE	REFER
---	Forging	5.75	R.T.	L-T	240.0	2.499	1.249	CT	1.273	0.40	96.50	98.7	11.3	1990	MA018
		5.75			248.0	2.492	1.255	CT	1.260	0.45	105.40			1990	MA018
		5.75			249.0	2.512	1.252	CT	1.293	0.24	77.10			1990	MA018
		5.75			251.0	2.503	1.249	CT	1.329	0.46	107.80			1990	MA018
		5.75			256.0	2.526	1.269	CT	1.354	0.41	103.20			1990	MA018
		5.75			257.0	2.511	1.266	CT	1.323	0.40	102.40			1990	MA018
---	Forging	5.75	R.T.	T-L	240.0	2.502	1.252	CT	1.306	0.47	104.50	105.6	4.8	1990	MA018
		5.75			243.0	2.501	1.251	CT	1.276	0.52	110.90			1990	MA018
		5.75			247.0	2.502	1.251	CT	1.370	0.42	101.40			1990	MA018
---	Forging	5.75	R.T.	R-L	247.1	2.500	1.250	CT	1.275	0.26	79.40	---	---	1990	MA018
1575 FOR 1HR; -100F FOR 3HR; 925F FOR 6 HR	Forging	6.50	R.T.	T-L	252.9	2.499	1.252	CT	1.257	0.69	133.20	---	---	1990	MA018
1575 FOR 2HR; -100F FOR 3HR; 925F FOR 6 HR	Forging	6.50	R.T.	T-L	253.9	2.501	1.252	CT	1.273	0.67	131.60	---	---	1990	MA018
1575F FOR 1HR AIR COOLED; 1575F FOR 1HR; -100F FOR 3HR; 925F 6 HR	Forging	6.50	R.T.	L-T	250.6	1.277	1.283	CT	1.293	0.71	133.50	---	---	1990	MA018
1575F FOR 1HR AIR/FAN COOLED; -100F FOR 3HR; AIR WARMED 925F FOR 6 HR	Forging	6.50	R.T.	L-T	248.3	2.503	1.251	CT	1.275	0.87	146.50	---	---	1990	MA018
1575F FOR 2HR AIR COOLED; -100F FOR 3HR; 925F 6HR	Forging	6.50	R.T.	L-T	253.2	2.503	1.256	CT	1.270	0.59	123.40	---	---	1990	MA018
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	Plate	2.00	-65	L-T	235.7	3.500	1.750	CT	---	0.54	109.90	---	---	1977	RI001
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	Plate	2.00	-65	T-L	248.6	3.500	1.750	CT	---	0.49	111.10	---	---	1977	RI001

TABLE 3.28.2.1 (CONCLUDED)

ALLOY STEEL AF 1410 K_{Ic}

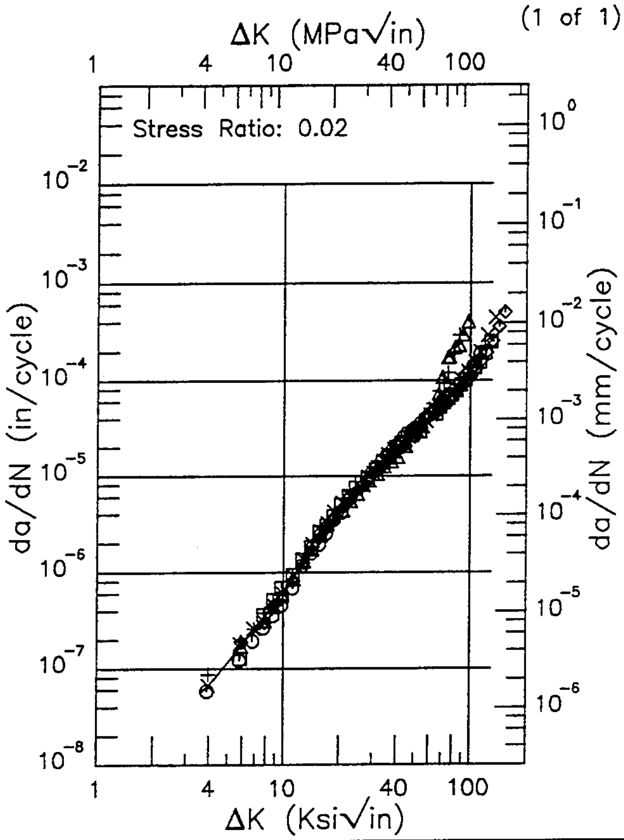
CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	Plate	2.00	R.T.	L-T	228.4	3.500	1.750	CT	---	1.04	147.80	139.6	11.7	1977	RI001
		2.00			228.4	3.500	1.750	CT	---	0.82	131.30			1977	RI001
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	Plate	2.00	R.T.	T-L	228.4	3.500	1.750	CT	---	0.96	141.90	136.7	7.4	1977	RI001
		2.00			228.4	3.500	1.750	CT	---	0.82	131.40			1977	RI001
1650F FOR 2HR AIR COOLED; 1250F FOR 8HR; 1575 FOR 1HR; -100F FOR 3HR; 925 FOR 6 HR	Forging	6.50	R.T.	T-L	250.8	2.497	1.257	CT	1.266	0.77	139.40	---	---	1990	MA018
1650F FOR 2HR AIR COOLED; 1250F FOR 8HR; 1575 FOR 1HR; -100F FOR 3HR; 925 FOR 6 HR	Forging	6.50	R.T.	L-T	251.5	20.504	1.256	CT	1.301	0.67	129.90	---	---	1990	MA018
AGED AT 900F FOR 5 HOURS	Bar	3.25	R.T.	L-R	241.5	2.494	1.250	CT	1.277	0.40	97.20	83.7	19.1	1990	MA018
		3.25			251.4	2.494	1.248	CT	1.308	0.19	70.20			1990	MA018
AGED AT 900F FOR 5 HOURS	Bar	3.25	R.T.	R-L	246.5	2.499	1.254	CT	1.304	0.19	67.30	---	---	1990	MA018
AGED AT 925F FOR 5 HOURS	Bar	3.25	R.T.	R-L	242.6	2.549	1.246	CT	1.354	0.35	90.60	---	---	1990	MA018
REAGED AT 925F FOR 10 HOURS	Forging	6.50	R.T.	T-L	246.3	2.501	1.254	CT	1.296	0.78	137.40	---	---	1990	MA018
REAGED AT 925F FOR 10 HOURS	Bar	3.25	R.T.	L-R	239.7	2.529	1.313	CT	1.384	0.37	92.00	---	---	1990	MA018
REAGED AT 925F FOR 7.5 HOURS	Bar	3.25	R.T.	R-L	249.7	2.503	1.260	CT	1.292	0.22	73.90	---	---	1990	MA018

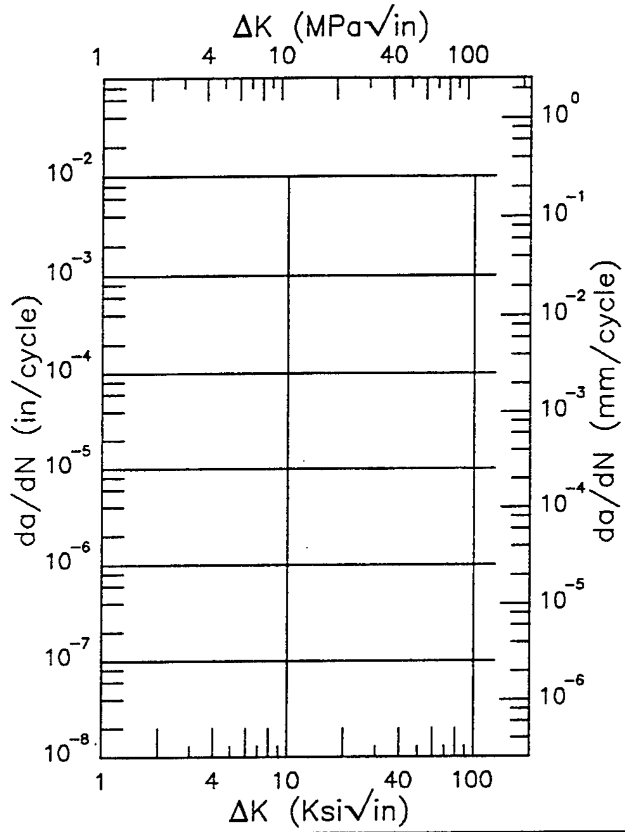
R

AF1410

Condition/Ht: 1525F 1HR AC −100F 1HR AC	950F 5HRS AC
Form: 4.25 – 4.5 in. Round Bar	Yield Strength: 209 – 222 ksi
Specimen Type: WOL	Ult. Strength: 240 – 247 ksi
Orientation: L–T	Specimen Thk: 0.499 – 0.506 in.
Frequency: 0.1 – 30 Hz	Specimen Width: 2.981 – 3.006 in.
Environment: LAB AIR; RT	Ref: MA004

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.88 (min)	0.0623
4.	0.0670
5.	0.115
6.	0.179
7.	0.262
8.	0.365
9.	0.490
10.	0.638
16.	2.06
20.	3.60
30.	9.72
40.	19.4
60.	49.6
80.	94.0
100.	151.
130.	259.
152.83 (max)	354.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

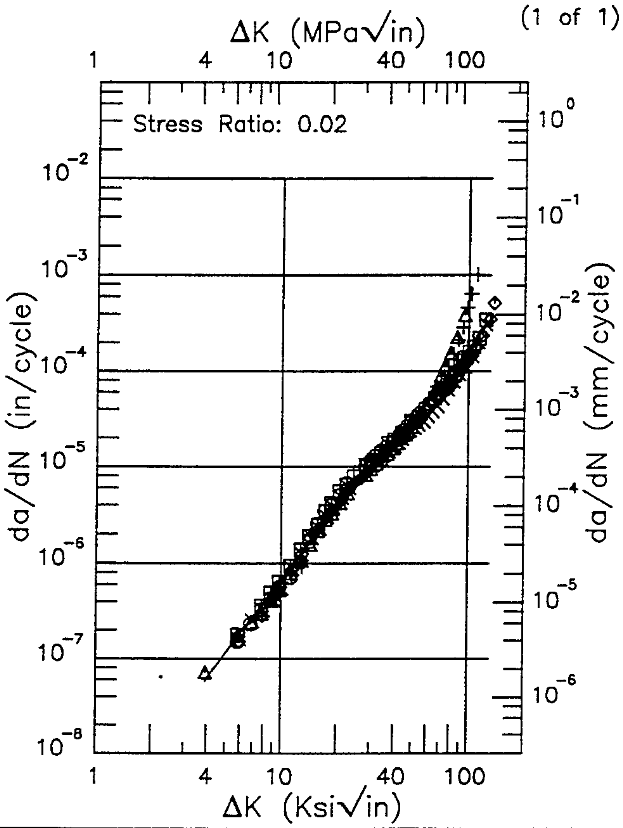
RMS % Error	Life Prediction Ratio Summary
30.80	⊗ × + 0. .5 .8 1.25 2.

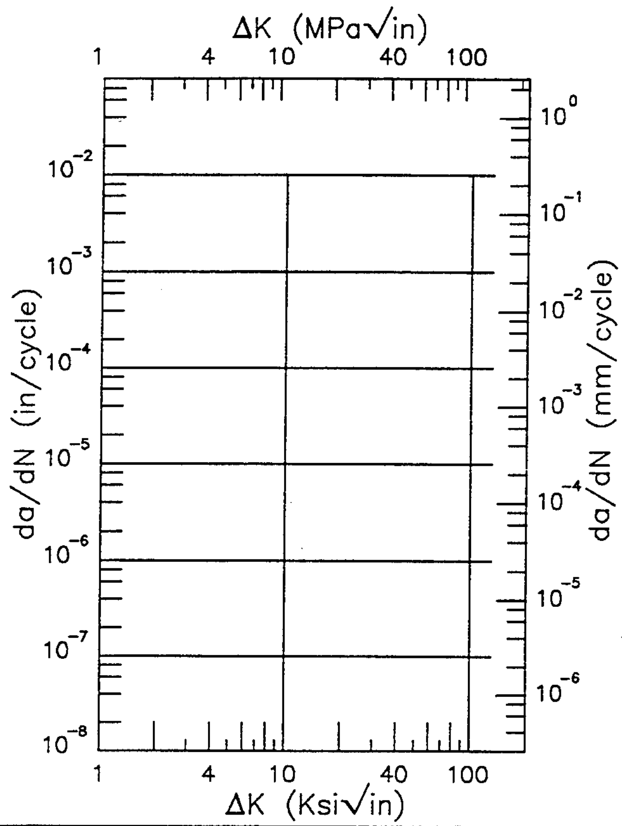
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.28.3.1.1

Condition/Ht: 1525F 1HR AC −100F 1HR AC	950F 5HRS AC
Form: 4.25 – 4.5 in. Round Bar	Yield Strength: 211 – 221 ksi
Specimen Type: WOL	Ult. Strength: 243 – 249 ksi
Orientation: T–L	Specimen Thk: 0.498 – 0.506 in.
Frequency: 0.1 – 30 Hz	Specimen Width: 2.979 – 2.995 in.
Environment: LAB AIR; RT	Ref: MA004

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.92 (min)	0.0583
4.	0.0617
5.	0.114
6.	0.185
7.	0.277
8.	0.390
9.	0.524
10.	0.682
16.	2.14
20.	3.64
30.	9.47
40.	18.7
60.	49.1
80.	98.9
100.	173.
130.	338.
135.83 (max)	379.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
40.12	0. .5 .8 1.25 2.

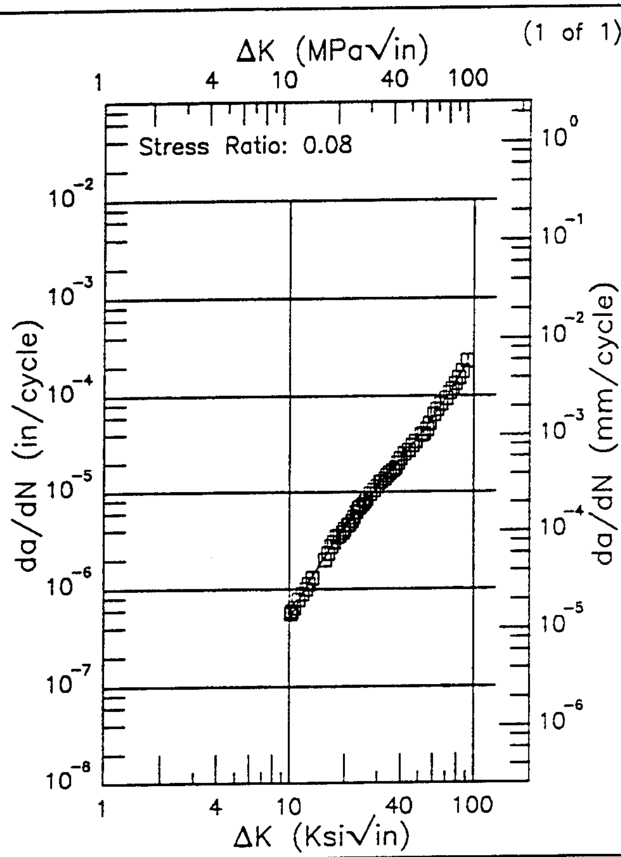
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

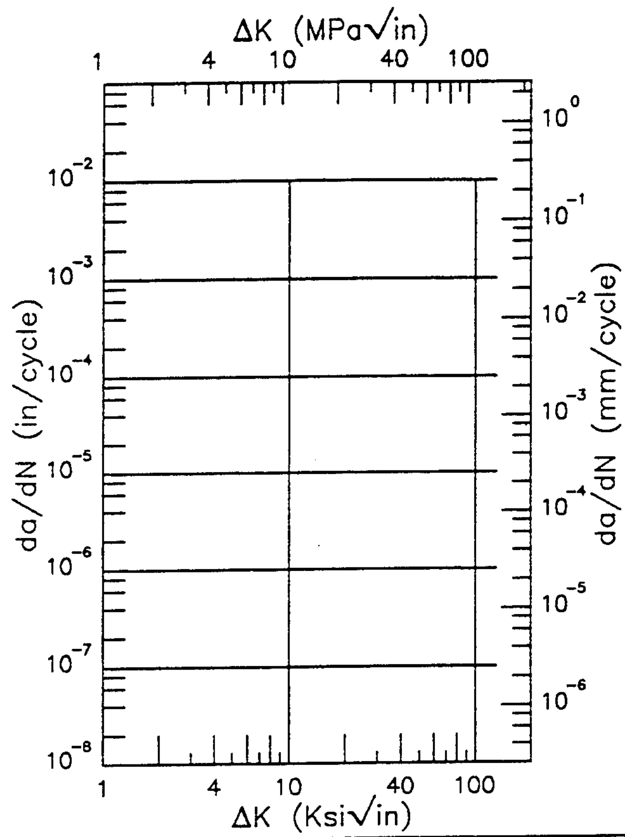
Figure 3.28.3.1.2

R AF1410

Condition/Ht: AIR QUENCHED	Yield Strength: 213 ksi
Form: 1 in. Plate	Ult. Strength:
Specimen Type: CT	Specimen Thk: 1.002 in.
Orientation:	Specimen Width: 4.94 in.
Frequency: 10 – 30 Hz	Ref: RI011
Environment: LAB AIR; RT	

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.12 (min)	0.519
13.	1.24
16.	2.31
20.	4.20
25.	7.26
30.	11.1
35.	15.8
40.	21.6
50.	37.1
60.	59.7
70.	92.5
80.	139.
90.	206.
91.54 (max)	219.

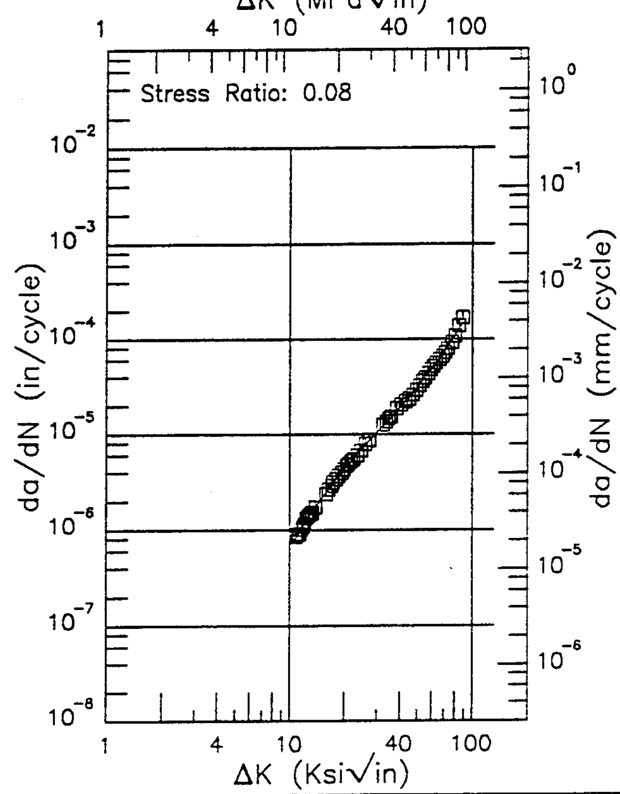
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

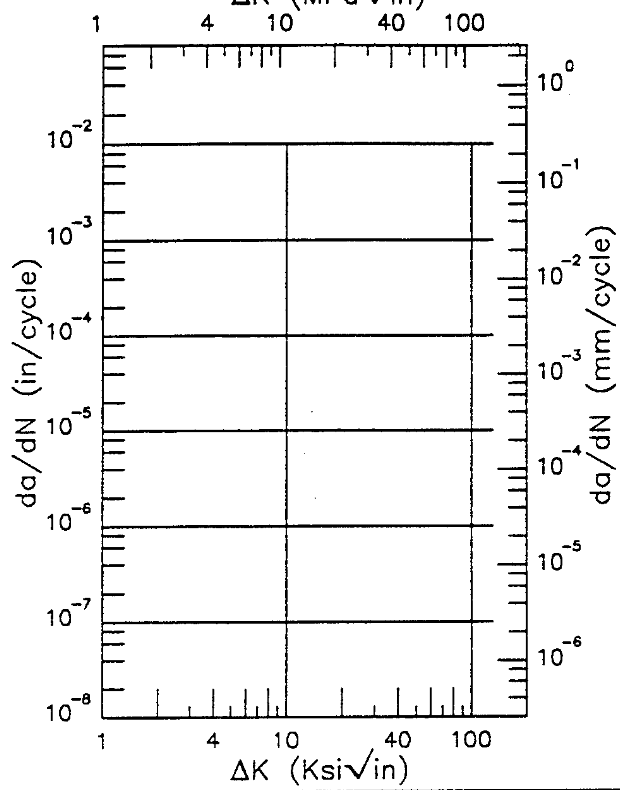
RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
3.94	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.28.3.1.3

Condition/Ht: OIL QUENCHED	
Form: 1 in. Plate	Yield Strength: 213 ksi
Specimen Type: CT	Ult. Strength:
Orientation:	Specimen Thk: 1.002 in.
Frequency: 1 – 30 Hz	Specimen Width: 4.94 in.
Environment: LAB AIR; RT	Ref: RI011

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
10.77 (min)	0.800
13.	1.45
16.	2.56
20.	4.40
25.	7.16
30.	10.4
35.	14.3
40.	18.9
50.	31.0
60.	48.2
70.	72.8
80.	108.
88.38 (max)	148.

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
3.58	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.28.3.1.4

TABLE 3.29.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK AF1410(VIM-VAR) AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	PLATE	0.08	30			0.65	3.88	27.26	

TABLE 3.29.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK AF1410(VIM-VAR) AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	PLATE	0.08	1-30				5.53	30.82	
		0.08	1-30				5.53	30.82	

TABLE 3.29.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK AF1410(VIM-VAR) AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	PLATE	0.08	1-30				4.97	29.51	
		0.08	1-30				4.97	29.51	
		0.3	1-30				6.08	39.21	
		0.3	1-30				6.08	39.21	

TABLE 3.29.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK AF1410(VIM-VAR) AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

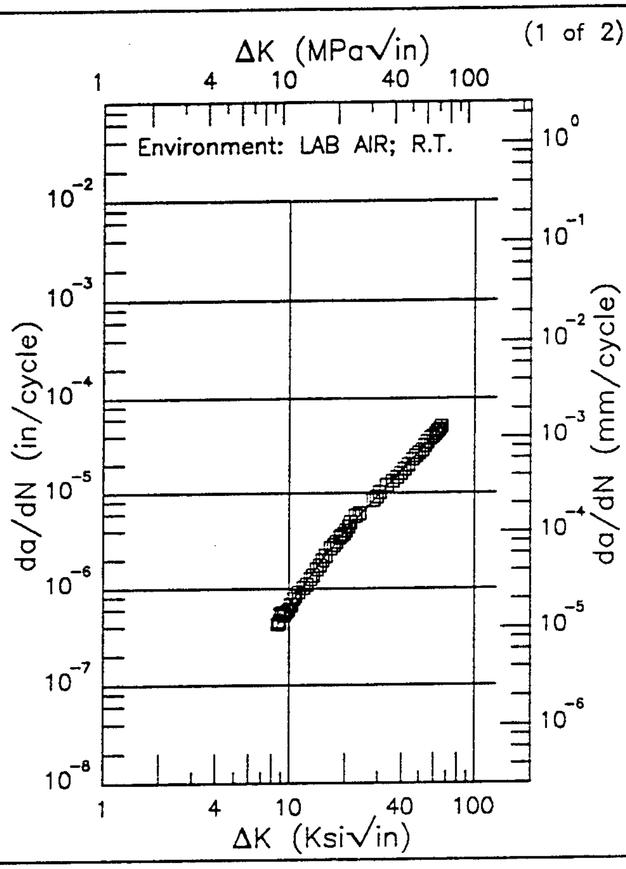
CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*) 2.5	5.0	10.0	20.0	50.0	100.0
1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC	PLATE	0.08	1-30			0.71	3.95	29.34	
		0.08	1-30			0.71	3.95	29.34	
		0.3	10-30			1.11	5.35	36.14	
		0.3	10-30			1.11	5.35	36.14	

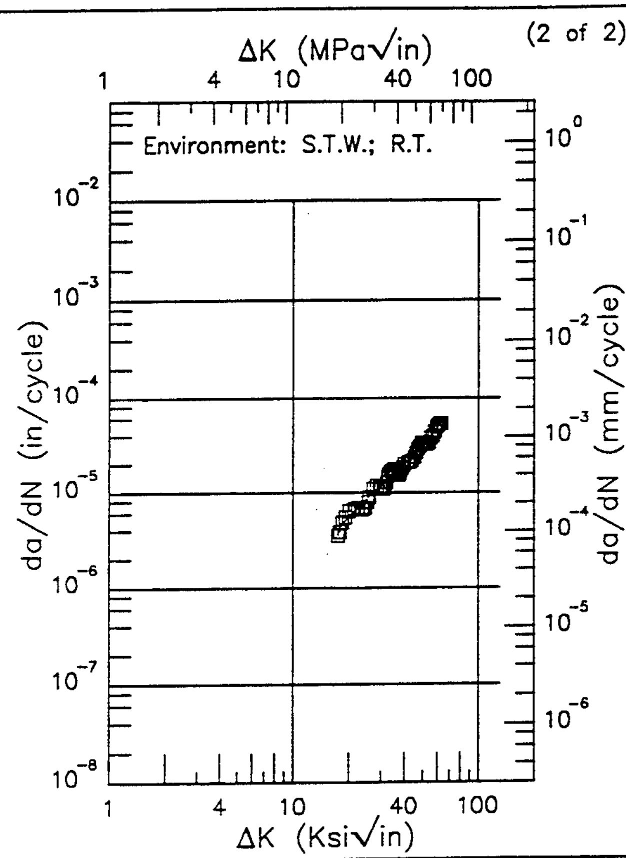
E

AF1410(VIM–VAR)

Condition/Ht: 1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC
Form: 1.75 in. Plate
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.08
Frequency: 1 – 30 Hz

Yield Strength: 234 ksi
Ult. Strength: 248.1 ksi
Specimen Thk: 0.997 – 0.998 in.
Specimen Width: 4.94 in.
Ref: RI001





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
8.60 (min)	0.409
9.	0.471
10.	0.646
13.	1.34
16.	2.28
20.	3.88
25.	6.39
30.	9.45
35.	13.1
40.	17.2
50.	27.3
60.	39.9
65.69 (max)	48.3

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
17.40 (min)	4.04
20.	5.53
25.	8.55
30.	11.8
35.	15.4
40.	19.6
50.	30.8
60.	48.1
62.59 (max)	53.9

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
4.74	0. .5 .8 1.25 2.	8.33	0. .5 .8 1.25 2.

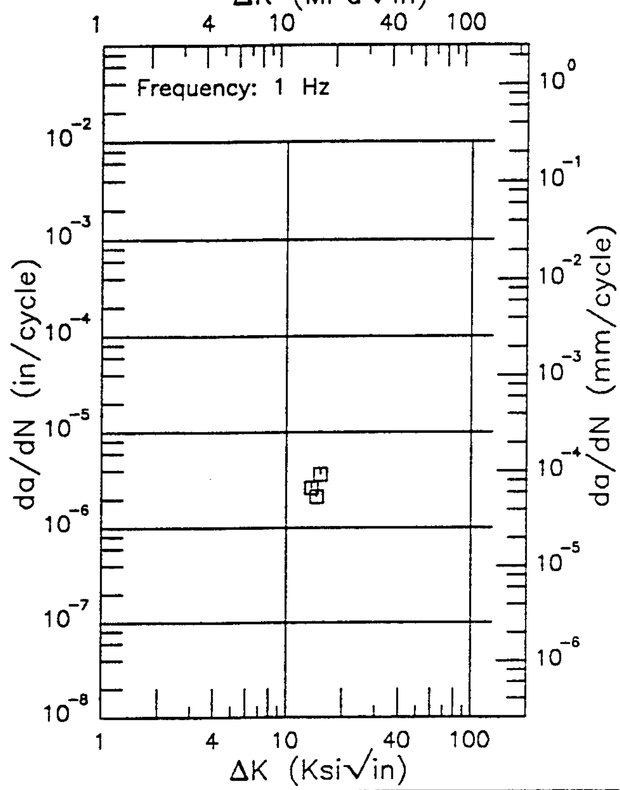
Figure 3.29.3.1.1

AF1410(VIM−VAR) F

Condition/Ht: 1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC
Form: 1.75 in. Plate
Specimen Type: CT
Orientation: L−T
Stress Ratio: 0.08
Environment: S.T.W.; RT

Yield Strength: 234 ksi
Ult. Strength: 248.1 ksi
Specimen Thk: 0.997 in.
Specimen Width: 4.94 in.
Ref: RI001

(1 of 2)



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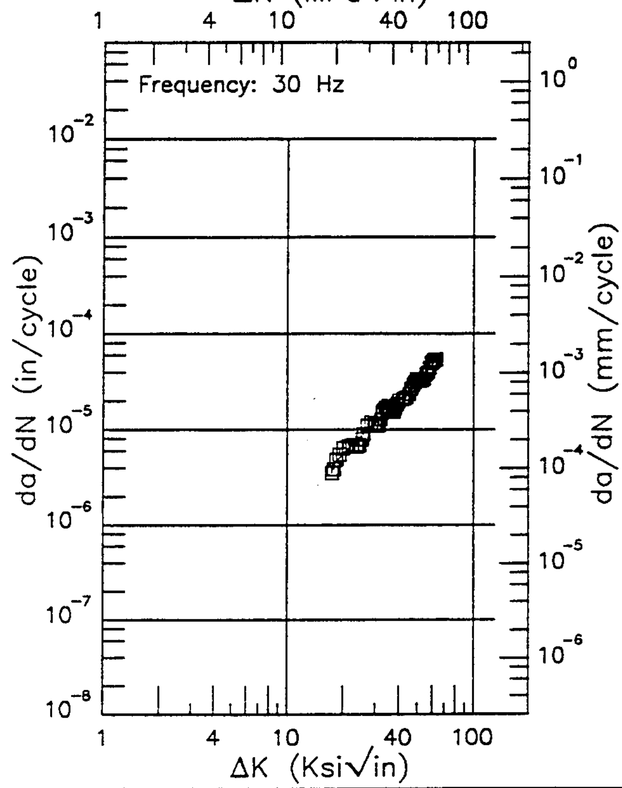


ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
17.40 (min)	4.04
20.	5.53
25.	8.55
30.	11.8
35.	15.4
40.	19.6
50.	30.8
60.	48.1
62.59 (max)	53.9

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.	8.33	0. .5 .8 1.25 2.

Figure 3.29.3.1.2

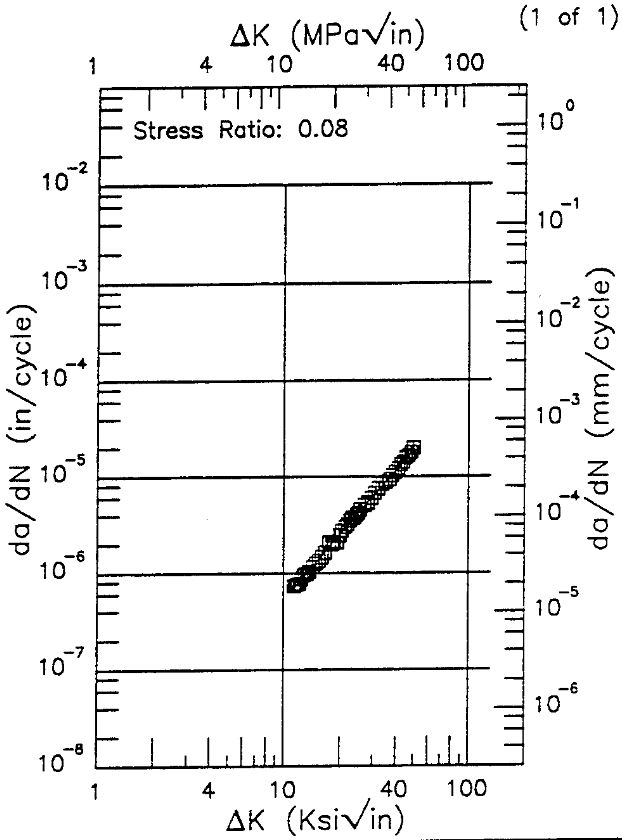
R

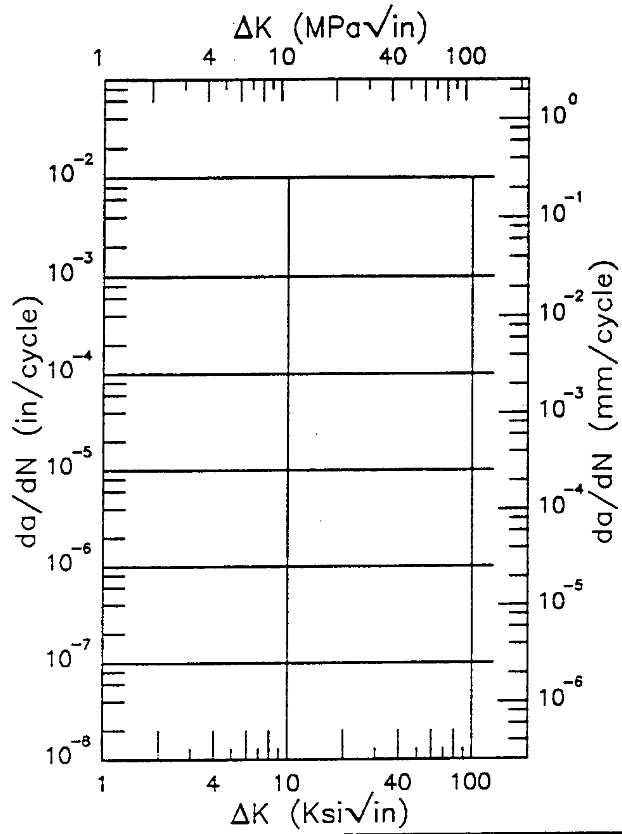
AF1410(VIM-VAR)

Condition/Ht: 1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC
Form: 1.75 in. Plate
Specimen Type: CT
Orientation: T-L
Frequency: 30 Hz
Environment: LAB AIR;-65°F

Yield Strength: 240 ksi
Ult. Strength: 258.2 ksi
Specimen Thk: 0.998 in.
Specimen Width: 4.94 in.
Ref: RI001

(1 of 1)



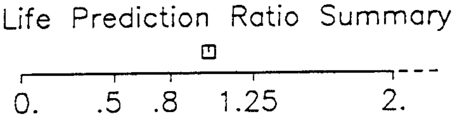


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.30 (min)	0.684
13.	0.947
16.	1.53
20.	2.55
25.	4.23
30.	6.33
35.	8.85
40.	11.8
49.56 (max)	18.3

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
4.15

Life Prediction Ratio Summary



RMS % Error

Life Prediction Ratio Summary

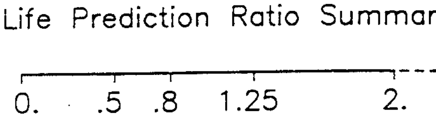
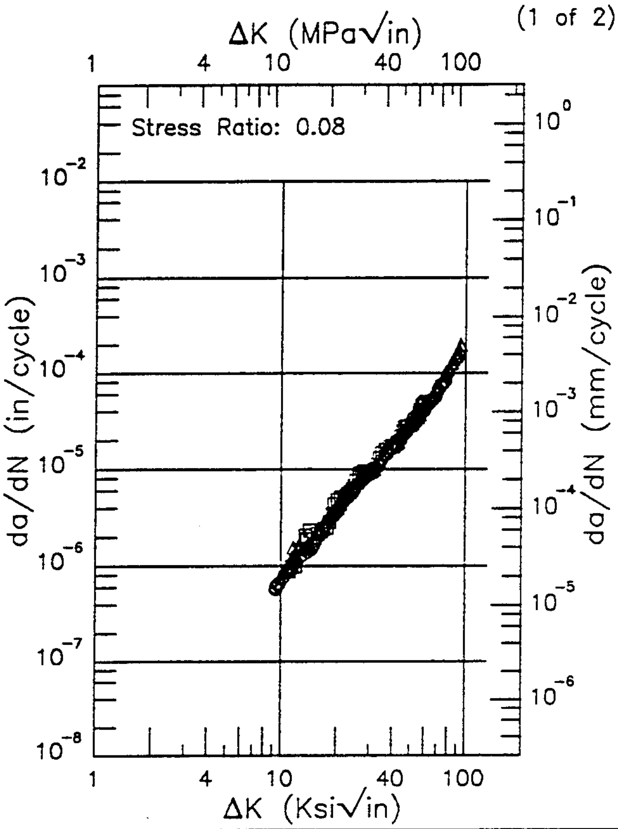


Figure 3.29.3.1.3

Condition/Ht: 1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC
Form: 1.75 in. Plate
Specimen Type: CT
Orientation: T-L
Frequency: 1 - 30 Hz
Environment: LAB AIR; RT
Yield Strength: 234 ksi
Ult. Strength: 247.8 ksi
Specimen Thk: 0.997 - 1.002 in.
Specimen Width: 4.94 - 4.95 in.
Ref: RI001

(1 of 2)



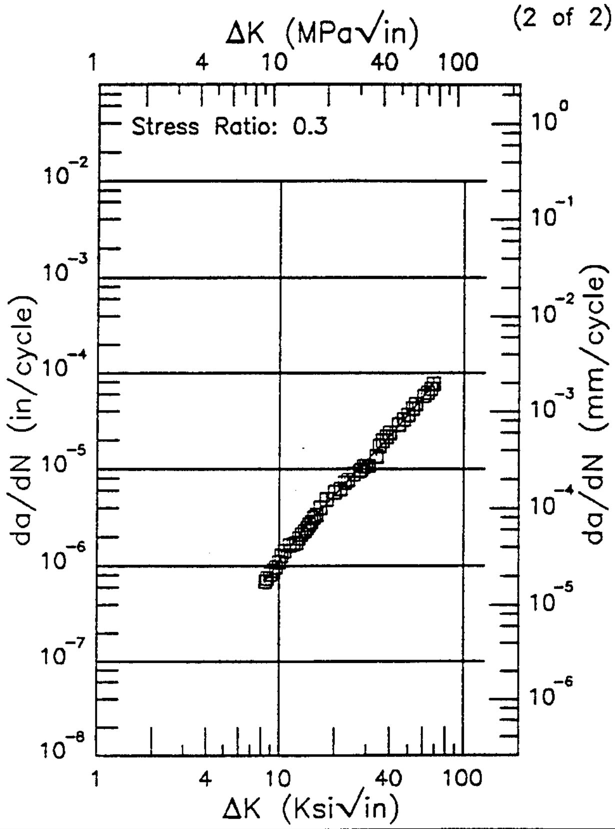
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.31 (min)	0.575
10.	0.711
13.	1.45
16.	2.40
20.	3.95
25.	6.37
30.	9.36
35.	13.0
40.	17.5
50.	29.3
60.	46.5
70.	71.1
80.	106.
90.	154.
93.58 (max)	176.

RMS % Error 9.55

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.38 (min)	0.683
9.	0.835
10.	1.11
13.	2.11
16.	3.36
20.	5.35
25.	8.40
30.	12.1
35.	16.6
40.	22.0
50.	36.1
60.	56.1
68.03 (max)	77.7

RMS % Error 5.73

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

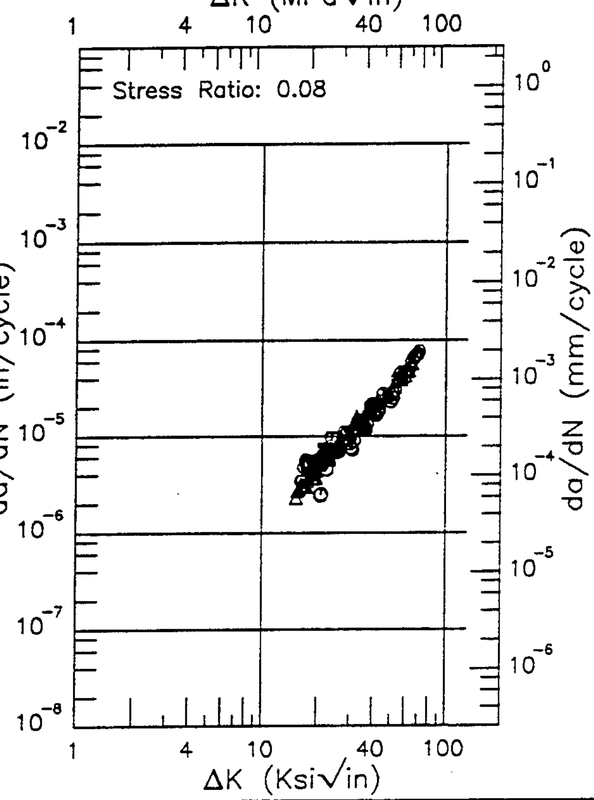
Figure 3.29.3.1.4

R AF1410(VIM–VAR)

Condition/Ht: 1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC
Form: 1.75 in. Plate
Specimen Type: CT
Orientation: T–L
Frequency: 1 – 30 Hz
Environment: 3.5% NACL; RT

Yield Strength: 234 ksi
Ult. Strength: 247.8 ksi
Specimen Thk: 0.998 – 1.001 in.
Specimen Width: 4.94 in.
Ref: RI001

(1 of 2)



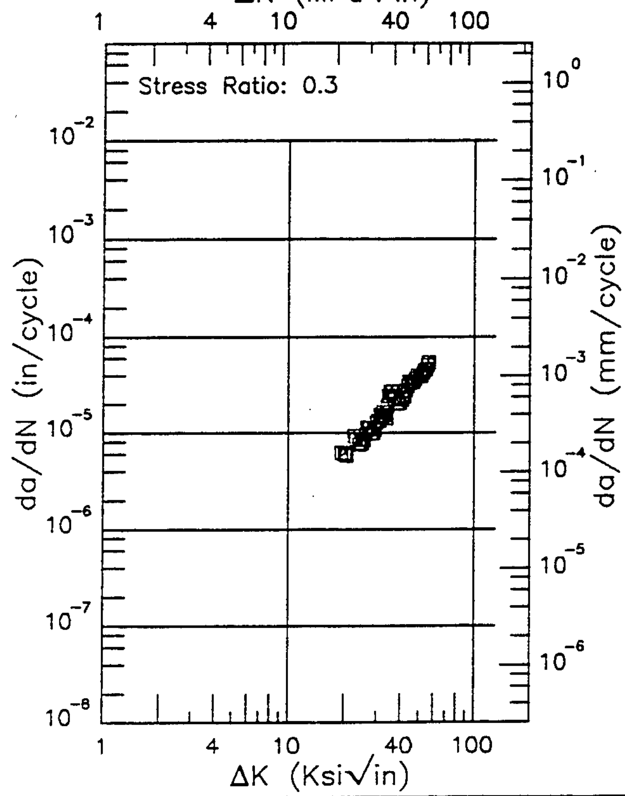
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.28 (min)	2.78
16.	3.09
20.	4.97
25.	7.57
30.	10.5
35.	14.0
40.	18.1
50.	29.5
60.	47.1
70.	74.5
70.51 (max)	76.2

RMS % Error 16.30

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.33 (min)	5.79
20.	6.08
25.	8.98
30.	13.2
35.	18.5
40.	24.9
50.	39.2
56.41 (max)	48.3

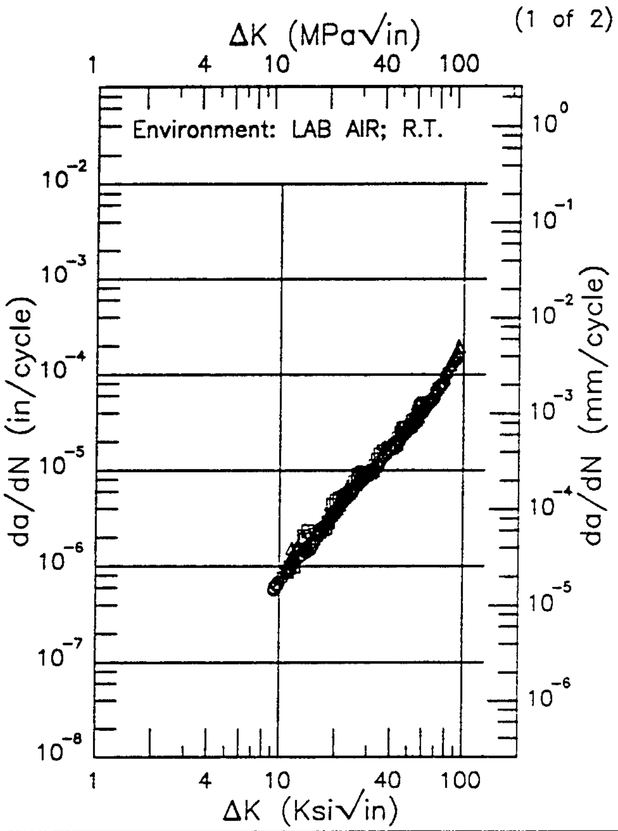
RMS % Error 12.77

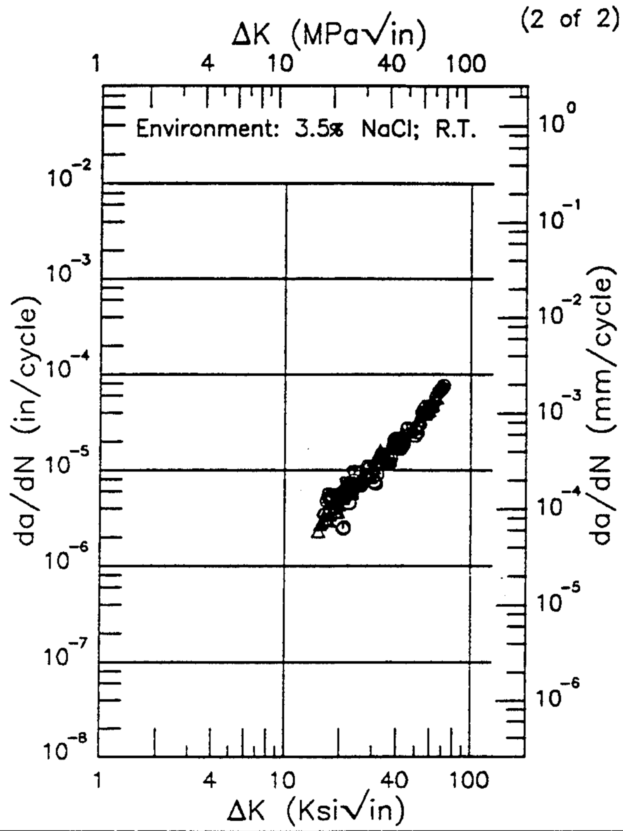
Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.29.3.1.5

Condition/Ht: 1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC
Form: 1.75 in. Plate
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.08
Frequency: 1 - 30 Hz
Yield Strength: 234 ksi
Ult. Strength: 247.8 ksi
Specimen Thk: 0.997 - 1.002 in.
Specimen Width: 4.94 - 4.95 in.
Ref: RI001



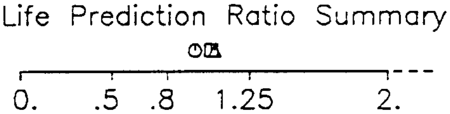


ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
9.31 (min)	0.575
10.	0.711
13.	1.45
16.	2.40
20.	3.95
25.	6.37
30.	9.36
35.	13.0
40.	17.5
50.	29.3
60.	46.5
70.	71.1
80.	106.
90.	154.
93.58 (max)	176.

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
15.28 (min)	2.78
16.	3.09
20.	4.97
25.	7.57
30.	10.5
35.	14.0
40.	18.1
50.	29.5
60.	47.1
70.	74.5
70.51 (max)	76.2

RMS % Error 9.55

Life Prediction Ratio Summary



RMS % Error 16.30

Life Prediction Ratio Summary

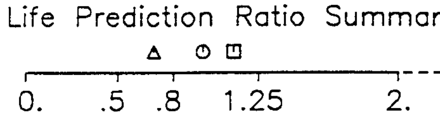


Figure 3.29.3.1.6

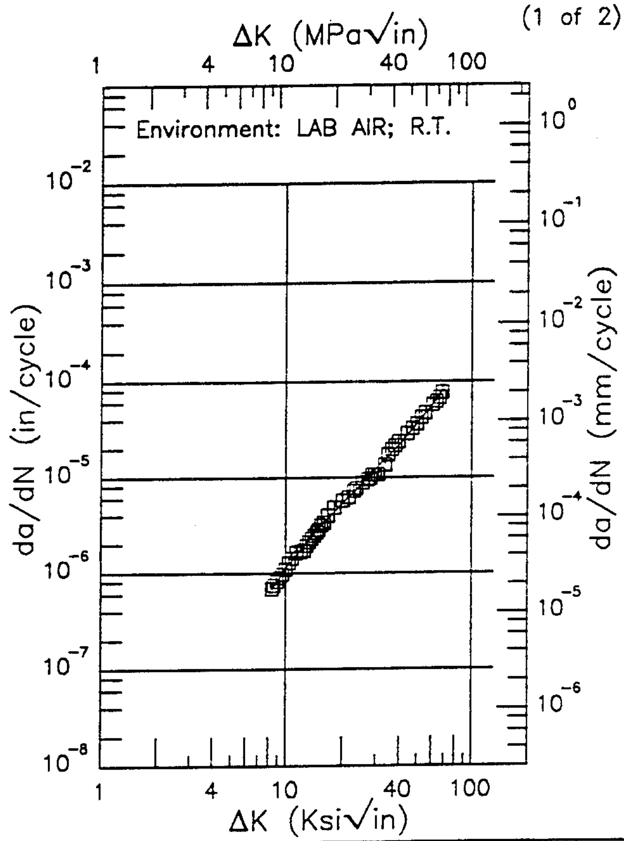
E

AF1410(VIM-VAR)

Condition/Ht: 1650F 1HR WQ 1500F 1HR WQ 950F 5HRS AC
Form: 1.75 in. Plate
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.3
Frequency: 1 – 30 Hz

Yield Strength: 234 ksi
Ult. Strength: 247.8 ksi
Specimen Thk: 0.998 in.
Specimen Width: 4.94 in.
Ref: RI001

(1 of 2)



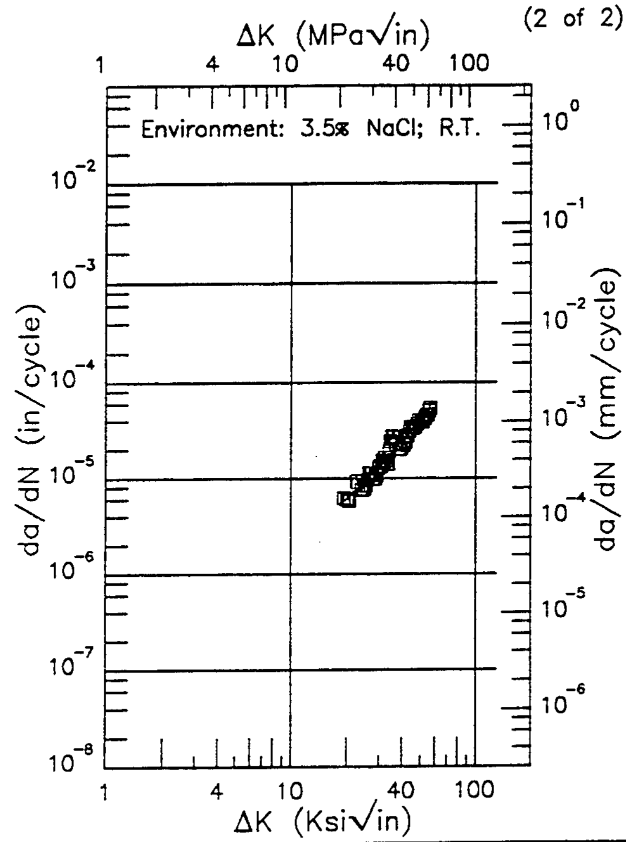
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.38 (min)	0.683
9.	0.835
10.	1.11
13.	2.11
16.	3.36
20.	5.35
25.	8.40
30.	12.1
35.	16.6
40.	22.0
50.	36.1
60.	56.1
68.03 (max)	77.7

RMS % Error 5.73

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.33 (min)	5.79
20.	6.08
25.	8.98
30.	13.2
35.	18.5
40.	24.9
50.	39.2
56.41 (max)	48.3

RMS % Error 12.77

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.29.3.1.7

TABLE 3.30.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL D6AC AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} ($ksi\sqrt{in}$)								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	1650F AUS-BAY QUENCH 975F SQ 1000F 2+2HR	66.9	18.7	7	---	---	---	---	---	---
	1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	62.2	14.	19	---	---	---	---	---	---
	1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	64.4	12.1	103	---	---	---	---	---	---
	1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2HR	92.	8.2	30	---	---	---	---	---	---
	HEAT TREATED TO 46 RC HARDNESS	---	---	---	85.8	1.8	2	---	---	---
Forging	1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR	---	---	---	78.4	15.1	6	83.9	14.8	52
	1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	46.	4.2	8	---	---	---	---	---	---
	1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	66.2	12.3	53	---	---	---	---	---	---

TABLE 3.30.1.1 (CONCLUDED)

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL D6AC AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging (Cont'd)	1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2HR	95.2	6.4	34	---	---	---	---	---	---
Billet	1650F 1HR FC 1650F 1HR OQ 1025F 2+2HR	78.5	4.7	2	---	---	---	---	---	---
	1650F 1HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	80.3	0.8	2	---	---	---	---	---	---
	1700F 1HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	80.3	4.3	3	---	---	---	---	---	---
	1700F 1HR OC 1025F 2+2HR	77.3	2.6	6	---	---	---	---	---	---
	1725F 1HR AC 1700F 1HR OQ 1000F 1HR 1015F 1HR	77.2	2.7	3	---	---	---	---	---	---
	1725F 1HR AC 1700F 1HR OQ 1025F 2+2HR	74.4	6.2	6	---	---	---	---	---	---
	1725F 1HR AC 1700F 1HR OQ 1100F 2+2HR	101.2	6.1	6	---	---	---	---	---	---
	1725F 1HR AC 1750F 1HR FC TO 960F SQ 350F 0.5HR AC 1025F 22HR	75.1	10.1	3	---	---	---	---	---	---

TABLE 3.30.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK D6AC AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) *ΔK Level (Ksi√in)* 2.5	5.0	10.0	20.0	50.0	100.0
1650F A-BQ AT 975F SQ AT 375F 1000F 2+2HR	FORGING	0.1	1			1.02	11.48		
1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS	PLATE	0.11	0.1				25.41		
		0.11	1				10.68		
		0.11	3				5.88		
		0.5	1			2.33	12.23		
		0.5	3			1.43	8.56		
	FORGING	0.1	0.1				15.73		
		0.1	1				9.61		
		0.1	3				6.68		
		0.48	1				11.44		

TABLE 3.30.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK D6AC AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Dry Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR	PLATE	0.09	0.1				5.58		
		0.09	1				5.24		
		0.09	3				5.43		
1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS	PLATE	0.1	0.1				5.28	43.92	
		0.1	1				5.66	40.17	
		0.1	3				4.86	43.29	

TABLE 3.30.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK D6AC AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: JP-4 Jet Fuel**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1650F A-BQ AT 975F SQ AT 375F 1000F 2+2HR	FORGING	0.1	1			0.65			
1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR	PLATE	0.1	0.1				10.42		
		0.1	1				7.44		
		0.1	3			0.74	5.31		
		0.5	1			2.41	9.62		
		0.5	3			1.09	6.45		
	FORGING	0.5	1				6		
1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS	PLATE	0.5	1				8.95		
		0.5	3				6.73		
	FORGING	0.1	0.1				14.82	87.62	
		0.1	1				8.37	37.44	
		0.1	3				3.73	39.44	

TABLE 3.30.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK D6AC AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR	PLATE	0.1	0.1					65.2	
		0.1	1				2.85		
		0.5	1				9.29		
1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS	PLATE	0.1	1				5.61	51.35	

TABLE 3.30.2.1

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi • √in.)	K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR	Forging	---	R.T.	L-S	197.9	2.000	1.006	CT	1.046	0.28	67.37	64.7	5.5	1979	MD001
		---			198.0	2.000	1.001	CT	1.061	0.29	68.26			1979	MD001
		---			199.8	1.997	1.001	CT	1.041	0.21	58.33			1980	MD001
1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR	Forging	---	R.T.	T-L	198.1	2.001	1.005	CT	1.048	0.33	72.62	78.4	15.1	1979	MD001
		---			198.1	2.000	1.005	CT	1.072	0.55	93.00			1979	MD001
		---			198.5	2.000	1.005	CT	1.069	0.55	93.67			1979	MD001
		---			198.5	2.000	1.001	CT	1.060	0.49	87.89			1979	MD001
		---			207.5	1.998	1.002	CT	1.024	0.20	59.04			1980	MD001
		---			207.5	1.997	1.000	CT	1.035	0.23	64.27			1980	MD001
1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR	Forging	---	R.T.	S-L	186.7	2.000	1.005	CT	1.045	0.55	88.32	83.9	14.8	1978	MD001
		---			186.7	2.000	1.005	CT	1.030	0.36	71.78			1978	MD001
		---			186.7	1.999	1.005	CT	1.042	0.71	99.54			1978	MD001
		---			187.2	1.990	1.002	CT	1.021	0.76	103.25			1978	MD001
		---			187.2	1.989	0.996	CT	1.003	0.81	106.64			1978	MD001
		---			187.2	1.987	0.996	CT	1.040	0.76	103.67			1979	MD001
		---			189.5	1.992	0.994	CT	1.016	0.63	95.25			1978	MD001
		---			189.5	1.997	0.993	CT	1.033	0.31	67.12			1978	MD001
		---			189.5	1.996	1.003	CT	1.024	0.35	71.23			1978	MD001
		---			189.5	1.996	0.995	CT	1.034	0.61	93.78			1978	MD001
		---			189.5	1.994	0.994	CT	1.023	0.63	95.37			1978	MD001
		---			189.5	1.993	0.994	CT	1.012	0.34	70.02			1978	MD001

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR Cont'd	Forging Cont'd	---	R.T. Cont'd	S-L Cont'd	191.0	2.002	0.991	CT	1.027	0.46	82.63	Cont'd	Cont'd	1979	MD001
		---			191.0	1.995	0.992	CT	1.021	0.45	81.67			1979	MD001
		---			191.0	2.001	0.990	CT	1.028	0.37	73.64			1979	MD001
		---			191.9	1.994	1.002	CT	1.035	0.50	86.37			1978	MD001
		---			191.9	1.996	1.003	CT	1.043	0.54	89.64			1978	MD001
		---			191.9	1.988	1.003	CT	1.033	0.57	92.34			1978	MD001
		---			192.8	2.004	0.991	CT	1.015	0.18	53.02			1979	MD001
		---			192.8	2.000	0.991	CT	1.019	0.17	51.11			1979	MD001
		---			192.8	2.000	0.991	CT	1.037	0.16	48.96			1979	MD001
		---			193.0	2.000	1.000	CT	1.044	0.34	71.92			1979	MD001
		---			193.0	1.999	0.965	CT	1.023	0.54	89.71			1979	MD001
		---			193.8	1.998	1.000	CT	1.031	0.27	64.19			1978	MD001
		---			193.8	2.000	1.001	CT	1.049	0.31	69.12			1977	MD001
		---			193.8	2.000	0.992	CT	1.024	0.30	68.14			1977	MD001
		---			194.1	2.001	0.997	CT	1.036	0.61	96.00			1980	MD001
		---			194.1	1.999	0.999	CT	1.076	0.41	78.90			1980	MD001
		---			194.1	1.999	0.996	CT	1.037	0.47	84.17			1980	MD001
		---			194.4	1.998	1.000	CT	1.026	0.43	80.69			1978	MD001
		---			194.5	2.000	1.004	CT	1.050	0.55	91.67			1977	MD001
		---			194.5	2.000	1.004	CT	1.062	0.55	91.59			1977	MD001
		---			195.5	1.999	1.002	CT	1.057	0.30	68.54			1979	MD001
		---			195.5	2.000	1.004	CT	1.025	0.29	67.40			1979	MD001

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1615F 2.25HR A-BQ 325F AC 310-345F 3HR 1080F 6-6.5HR Cont'd	Forging Cont'd	---	R.T. Cont'd	S-L Cont'd	196.3	1.999	1.003	CT	1.057	0.45	83.50	Cont'd	Cont'd	1979	MD001
		---			196.3	2.001	1.000	CT	1.058	0.60	96.67			1977	MD001
		---			196.3	1.998	1.000	CT	1.045	0.36	75.10			1978	MD001
		---			196.3	2.000	1.005	CT	1.040	0.55	92.69			1979	MD001
		---			196.9	1.999	1.002	CT	1.011	0.65	101.04			1978	MD001
		---			196.9	1.999	1.002	CT	1.017	0.67	102.31			1979	MD001
		---			196.9	1.999	1.002	CT	1.034	0.63	99.31			1978	MD001
		---			200.2	1.999	1.007	CT	1.014	0.38	78.63			1978	MD001
		---			200.2	1.999	1.007	CT	1.025	0.35	75.67			1978	MD001
		---			200.2	1.999	1.007	CT	1.027	0.35	75.91			1978	MD001
		---			201.5	1.997	1.000	CT	1.036	0.65	103.09			1978	MD001
		---			201.5	1.997	0.999	CT	1.052	0.60	99.19			1978	MD001
		---			201.5	1.997	0.999	CT	1.037	0.67	104.62			1978	MD001
		---			202.3	2.003	1.000	CT	1.038	0.55	95.21			1977	MD001
		---			202.3	2.000	1.000	CT	1.042	0.56	95.80			1977	MD001
		---			202.3	2.001	0.999	CT	1.042	0.55	95.58			1977	MD001
		---			202.7	2.000	1.002	CT	1.037	0.32	73.46			1980	MD001
		---			202.7	1.995	1.001	CT	1.037	0.25	65.34			1980	MD001
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	-65	L-T	228.0	1.501	0.750	CT	0.790	0.05	31.20	37.0	6.9	1972	82543
		0.80			228.0	1.502	0.757	CT	0.759	0.11	47.00			1972	82543
		1.50			228.0	1.499	0.750	CT	0.760	0.06	35.80			1972	82543
		1.50			228.0	1.499	0.750	CT	0.854	0.05	34.10			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	-40	L-T	227.0	1.500	0.750	CT	0.771	0.05	32.00	34.1	2.9	1972	82543
		1.50			227.0	1.502	0.750	CT	0.781	0.06	36.10			1972	82543
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	-20	L-T	226.0	1.500	0.750	CT	0.777	0.07	37.20	43.3	10.9	1972	82543
		0.80			226.0	1.502	0.757	CT	0.769	0.15	55.70			1972	82543
		0.80			226.0	1.503	0.757	CT	0.765	0.15	54.60			1972	82543
		1.50			226.0	1.499	0.749	CT	0.811	0.06	34.50			1972	82543
		1.50			226.0	1.500	0.750	CT	0.786	0.06	34.60			1972	82543
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	0	L-T	224.0	1.499	0.750	CT	0.817	0.08	39.60	42.0	3.2	1972	82543
		1.50			224.0	1.499	0.750	CT	0.784	0.08	40.70			1972	82543
		1.50			224.0	1.499	0.750	CT	0.789	0.10	45.60			1972	82543
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	20	L-T	222.0	1.503	0.750	CT	0.768	0.10	44.60	40.0	4.4	1972	82543
		1.50			222.0	1.500	0.750	CT	0.837	0.08	39.60			1972	82543
		1.50			222.0	1.499	0.750	CT	0.780	0.06	35.80			1972	82543
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	40	L-T	220.0	1.499	0.751	CT	0.787	0.13	50.00	44.7	5.7	1972	82543
		1.50			220.0	1.503	0.750	CT	0.777	0.08	38.70			1972	82543
		1.50			220.0	1.502	0.748	CT	0.815	0.11	45.50			1972	82543
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	0.80	R.T.	L-T	217.0	1.499	0.750	CT	0.769	0.36	82.70	66.9	18.7	1972	82543
		1.50			217.0	1.502	0.756	CT	0.777	0.11	45.80			1972	82543
		1.50			217.0	1.498	0.755	CT	0.790	0.13	48.70			1972	82543
		0.80			217.0	1.504	0.757	CT	0.767	0.35	81.00			1972	82543
		0.80			217.0	1.502	0.757	CT	0.750	0.34	80.10			1972	82543
		0.80			217.0	1.502	0.755	CT	0.765	0.37	83.60			1972	82543
		1.50			217.0	1.501	0.755	CT	0.815	0.12	46.50			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	175	L-T	211.0	1.498	0.750	CT	0.763	0.30	72.50	74.7	2.0	1972	82543
		1.50			211.0	1.502	0.750	CT	0.823	0.32	75.40			1972	82543
		1.50			211.0	1.499	0.750	CT	0.768	0.32	76.30			1972	82543
1650F AUS-BAY QUENCH 975F SQ 325F 1000F 2+2HR	Plate	1.50	300	L-T	204.0	1.496	0.751	CT	0.763	0.61	100.80	104.2	3.0	1972	82543
		1.50			204.0	1.501	0.750	CT	0.798	0.67	105.40			1972	82543
		1.50			204.0	1.503	0.750	CT	0.772	0.68	106.40			1972	82543
1650F 1 HR FC 1650F 1HR OQ 1025F 2+2HR	Billet	7.00	R.T.	L-T	210.0	2.500	1.000	CT	1.400	0.32	75.10	78.5	4.7	1972	84277
		7.00			210.0	2.500	1.000	CT	1.400	0.38	81.80			1972	84277
1650F 1 HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	Billet	7.00	R.T.	L-T	211.0	2.500	1.000	CT	1.400	0.37	80.90	80.3	0.8	1972	84277
		7.00			211.0	2.500	1.000	CT	1.400	0.36	79.70			1972	84277
1650F 1 HR FC TO 960F OQ AT 180F AC 1025F 2+2HR	Forging	1.50	R.T.	---	219.0	1.000	0.500	CT	0.500	0.40	88.00	87.7	0.7	1972	84277
		1.50			219.0	1.000	0.500	CT	0.500	0.41	88.30			1972	84277
		1.50			219.0	1.000	0.500	CT	0.500	0.39	86.90			1972	84277
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Plate	1.50	R.T.	L-T	217.0	1.202	0.608	CT	0.645	0.17	56.80	62.2	14.0	1972	82543
		1.50			217.0	1.199	0.599	CT	0.625	0.35	81.10			1972	82543
		1.50			217.0	1.199	0.608	CT	0.612	0.14	50.40			1972	82543
		1.50			217.0	1.201	0.602	CT	0.618	0.32	77.90			1972	82543
		1.50			217.0	1.196	0.608	CT	0.642	0.09	40.20			1972	82543
		1.50			217.0	1.200	0.605	CT	0.619	0.12	47.40			1972	82543
		1.50			217.0	1.205	0.605	CT	0.641	0.30	75.10			1972	82543
		1.50			217.0	1.204	0.605	CT	0.648	0.21	62.60			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR Cont'd	Plate Cont'd	1.50	R.T. Cont'd	L-T Cont'd	217.0	1.197	0.604	CT	0.644	0.28	72.20	Cont'd	Cont'd	1972	82543
		1.50			217.0	1.198	0.605	CT	0.636	0.18	57.80			1972	82543
		1.50			217.0	1.202	0.604	CT	0.641	0.31	76.50			1972	82543
		1.50			217.0	1.195	0.605	CT	0.621	0.26	69.40			1972	82543
		1.50			217.0	1.211	0.607	CT	0.632	0.14	50.40			1972	82543
		1.50			217.0	1.201	0.599	CT	0.618	0.12	48.00			1972	82543
		1.50			217.0	1.203	0.608	CT	0.623	0.12	47.70			1972	82543
		1.50			217.0	1.204	0.607	CT	0.628	0.25	68.20			1972	82543
		1.50			217.0	1.193	0.604	CT	0.610	0.12	46.80			1972	82543
		1.50			217.0	1.200	0.605	CT	0.630	0.41	87.90			1972	82543
		1.50			217.0	1.201	0.600	CT	0.599	0.23	66.30			1972	82543
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	-65	L-T	225.0	1.507	0.756	CT	0.773	0.05	31.80	31.8	0.0	1972	82543
		1.50			225.0	1.507	0.756	CT	0.773	0.05	31.80			1972	82543
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	-20	L-T	222.0	1.506	0.755	CT	0.768	0.06	35.50	34.8	0.6	1972	82543
		1.50			222.0	1.504	0.753	CT	0.755	0.06	34.50			1972	82543
		1.50			222.0	1.506	0.755	CT	0.758	0.06	34.50			1972	82543
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	0	L-T	220.0	1.504	0.755	CT	0.791	0.06	34.60	---	---	1972	82543
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	20	L-T	218.0	1.506	0.755	CT	0.782	0.08	39.00	37.5	3.5	1972	82543
		1.50			218.0	1.506	0.756	CT	0.773	0.08	39.90			1972	82543
		1.50			218.0	1.503	0.751	CT	0.785	0.06	33.50			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	R.T.	L-T	214.0	1.501	0.753	CT	0.771	0.13	48.40	46.0	4.2	1972	82543
		1.50			214.0	1.497	0.753	CT	0.762	0.16	54.40			1972	82543
		1.50			214.0	1.508	0.755	CT	0.766	0.11	45.10			1972	82543
		1.50			214.0	1.503	0.755	CT	0.794	0.11	44.70			1972	82543
		1.50			214.0	1.514	0.755	CT	0.764	0.12	46.10			1972	82543
		1.50			214.0	1.504	0.750	CT	0.783	0.10	42.40			1972	82543
		1.50			214.0	1.502	0.753	CT	0.767	0.09	40.30			1972	82543
		1.50			214.0	1.502	0.750	CT	0.768	0.12	46.80			1972	82543
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	175	L-T	208.0	1.503	0.750	CT	0.775	0.33	75.60	64.1	10.0	1972	82543
		1.50			208.0	1.501	0.755	CT	0.780	0.19	57.30			1972	82543
		1.50			208.0	1.497	0.750	CT	0.773	0.20	59.40			1972	82543
1650F AUS-BAY QUENCH 975F SQ 375F 1000F 2+2HR	Forging	1.50	300	L-T	201.0	1.501	0.753	CT	0.762	0.51	90.50	92.0	2.1	1972	82543
		1.50			201.0	1.502	0.755	CT	0.779	0.54	93.40			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	-65	L-T	228.0	1.501	0.755	CT	0.743	0.04	30.40	33.2	2.8	1972	82543
		0.80			228.0	1.507	0.759	CT	0.758	0.07	37.30			1972	82543
		0.80			228.0	1.504	0.758	CT	0.763	0.05	31.80			1972	82543
		0.80			228.0	1.504	0.755	CT	0.763	0.05	31.90			1972	82543
		0.80			228.0	1.503	0.751	CT	0.748	0.06	34.70			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	-40	L-T	227.0	1.496	0.757	CT	0.760	0.07	38.50	38.5	2.0	1972	82543
		0.80			227.0	1.498	0.757	CT	0.758	0.07	37.60			1972	82543
		0.80			227.0	1.502	0.693	CT	0.750	0.07	37.00			1972	82543
		0.80			227.0	1.499	0.758	CT	0.770	0.06	36.70			1972	82543
		0.80			227.0	1.505	0.693	CT	0.765	0.07	37.30			1972	82543
		0.80			228.0	1.201	0.599	CT	0.624	0.08	41.20			1972	82543
		0.80			228.0	1.201	0.599	CT	0.608	0.08	41.40			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	-20	L-T	226.0	1.501	0.757	CT	0.748	0.08	39.10	40.3	1.3	1972	82543
		0.80			226.0	1.502	0.757	CT	0.754	0.09	42.30			1972	82543
		0.80			226.0	1.501	0.757	CT	0.756	0.08	39.90			1972	82543
		0.80			226.0	1.501	0.755	CT	0.756	0.08	40.80			1972	82543
		0.80			226.0	1.498	0.757	CT	0.755	0.08	39.60			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	0	L-T	224.0	1.498	0.758	CT	0.772	0.10	44.50	42.4	2.2	1972	82543
		0.80			224.0	1.487	0.757	CT	0.746	0.08	40.20			1972	82543
		0.80			224.0	1.496	0.757	CT	0.781	0.09	42.40			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	20	L-T	222.0	1.500	0.757	CT	0.764	0.12	47.70	45.4	3.9	1972	82543
		0.80			222.0	1.503	0.758	CT	0.778	0.08	40.90			1972	82543
		0.80			222.0	1.502	0.758	CT	0.769	0.12	47.60			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	40	L-T	220.0	1.501	0.758	CT	0.773	0.14	51.30	52.8	2.1	1972	82543
		0.80			220.0	1.502	0.758	CT	0.770	0.15	54.30			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	R.T.	L-T	217.0	1.504	0.692	CT	0.752	0.16	56.00	64.4	12.1	1972	82543
		0.80			217.0	1.504	0.749	CT	0.769	0.28	72.70			1972	82543
		0.80			217.0	1.494	0.753	CT	0.773	0.16	54.70			1972	82543
		0.80			217.0	1.504	0.749	CT	0.767	0.39	86.10			1972	82543
		0.80			217.0	1.502	0.747	CT	0.771	0.42	89.40			1972	82543
		0.80			217.0	1.197	0.608	CT	0.622	0.16	54.20			1972	82543
		0.80			217.0	1.505	0.692	CT	0.747	0.18	57.70			1972	82543
		0.80			217.0	1.501	0.750	CT	0.756	0.16	54.00			1972	82543
		0.80			217.0	1.202	0.604	CT	0.633	0.35	80.80			1972	82543
		0.80			217.0	1.199	0.608	CT	0.617	0.34	79.60			1972	82543
		0.80			217.0	1.200	0.607	CT	0.624	0.35	81.50			1972	82543
		0.80			217.0	1.200	0.607	CT	0.622	0.28	73.30			1972	82543
		0.80			217.0	1.505	0.694	CT	0.770	0.16	55.70			1972	82543
		0.80			217.0	1.199	0.607	CT	0.624	0.36	81.90			1972	82543
		0.80			217.0	1.500	0.755	CT	0.762	0.24	66.70			1972	82543
		0.80			217.0	1.197	0.606	CT	0.622	0.28	56.10			1972	82543
		0.80			217.0	1.505	0.691	CT	0.755	0.15	53.90			1972	82543
		0.80			217.0	1.503	0.750	CT	0.768	0.14	52.00			1972	82543
		0.80			217.0	1.505	0.692	CT	0.765	0.18	59.00			1972	82543
		0.80			217.0	1.498	0.757	CT	0.756	0.24	66.60			1972	82543
		0.80			217.0	1.500	0.754	CT	0.762	0.36	81.70			1972	82543
		0.80			217.0	1.198	0.605	CT	0.623	0.20	61.90			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * (K_{Ic}/TYS)^2 (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR Cont'd	Plate Cont'd	0.80	R.T. Cont'd	L-T Cont'd	217.0	1.203	0.608	CT	0.625	0.29	73.40	Cont'd	Cont'd	1972	82543
		0.80			217.0	1.193	0.605	CT	0.613	0.17	57.50			1972	82543
		0.80			217.0	1.501	0.752	CT	0.765	0.11	46.40			1972	82543
		0.80			217.0	1.502	0.695	CT	0.762	0.10	44.50			1972	82543
		0.80			217.0	1.197	0.607	CT	0.625	0.42	88.80			1972	82543
		0.80			217.0	1.505	0.694	CT	0.755	0.19	59.40			1972	82543
		0.80			217.0	1.203	0.600	CT	0.635	0.18	58.90			1972	82543
		0.80			217.0	1.200	0.608	CT	0.616	0.18	58.60			1972	82543
		0.80			217.0	1.198	0.603	CT	0.636	0.17	56.00			1972	82543
		0.80			217.0	1.500	0.751	CT	0.729	0.32	77.10			1972	82543
		0.80			217.0	1.201	0.600	CT	0.622	0.19	59.50			1972	82543
		0.80			217.0	1.199	0.605	CT	0.621	0.44	91.00			1972	82543
		0.80			217.0	1.198	0.606	CT	0.619	0.18	58.00			1972	82543
		0.80			217.0	1.501	0.759	CT	0.756	0.18	48.50			1972	82543
		0.80			217.0	1.198	0.608	CT	0.622	0.14	52.10			1972	82543
		0.80			217.0	1.494	0.756	CT	0.755	0.18	58.60			1972	82543
		0.80			217.0	1.200	0.607	CT	0.620	0.31	76.80			1972	82543
		0.80			217.0	1.197	0.608	CT	0.617	0.31	76.60			1972	82543
		0.80			217.0	1.505	0.694	CT	0.758	0.21	62.90			1972	82543
		0.80			217.0	1.502	0.754	CT	0.766	0.37	83.60			1972	82543
		0.80			217.0	1.505	0.692	CT	0.759	0.16	55.40			1972	82543
		0.80			217.0	1.496	0.748	CT	0.744	0.20	60.80			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR Cont'd	Plate Cont'd	0.80	R.T. Cont'd	L-T Cont'd	217.0	1.504	0.693	CT	0.776	0.17	57.20	Cont'd	Cont'd	1972	82543
		0.80			217.0	1.505	0.691	CT	0.747	0.18	59.00			1972	82543
		0.80			217.0	1.199	0.606	CT	0.613	0.33	79.30			1972	82543
		0.80			217.0	1.505	0.692	CT	0.762	0.19	60.20			1972	82543
		0.80			217.0	1.498	0.757	CT	0.771	0.29	73.60			1972	82543
		0.80			217.0	1.202	0.607	CT	0.621	0.21	63.40			1972	82543
		0.80			217.0	1.505	0.694	CT	0.753	0.20	61.80			1972	82543
		0.80			217.0	1.496	0.756	CT	0.747	0.45	92.30			1972	82543
		0.80			217.0	1.502	0.692	CT	0.779	0.20	61.90			1972	82543
		0.80			217.0	1.501	0.692	CT	0.755	0.10	43.90			1972	82543
		0.80			217.0	1.203	0.606	CT	0.621	0.24	52.80			1972	82543
		0.80			217.0	1.505	0.694	CT	0.753	0.20	60.90			1972	82543
		0.80			217.0	1.504	0.692	CT	0.741	0.16	54.50			1972	82543
		0.80			217.0	1.202	0.605	CT	0.630	0.32	78.00			1972	82543
		0.80			217.0	1.498	0.749	CT	0.766	0.27	71.40			1972	82543
		0.80			217.0	1.502	0.755	CT	0.751	0.16	54.00			1972	82543
		0.80			217.0	1.497	0.757	CT	0.749	0.18	57.90			1972	82543
		0.80			217.0	1.198	0.605	CT	0.630	0.31	76.20			1972	82543
		0.80			217.0	1.199	0.606	CT	0.617	0.14	50.60			1972	82543
		0.80			217.0	1.500	0.758	CT	0.777	0.32	77.70			1972	82543
		0.80			217.0	1.504	0.692	CT	0.774	0.16	55.20			1972	82543
		0.80			217.0	1.504	0.692	CT	0.764	0.17	57.00			1972	82543
		0.80			217.0	1.196	0.605	CT	0.620	0.22	64.20			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR Cont'd	Plate Cont'd	0.80	R.T. Cont'd	L-T Cont'd	217.0	1.498	0.749	CT	0.838	0.23	66.00	Cont'd	Cont'd	1972	82543
		0.80			217.0	1.200	0.607	CT	0.625	0.30	75.40			1972	82543
		0.80			217.0	1.500	0.750	CT	0.764	0.15	52.80			1972	82543
		0.80			217.0	1.201	0.604	CT	0.641	0.18	58.00			1972	82543
		0.80			217.0	1.198	0.605	CT	0.624	0.20	61.80			1972	82543
		0.80			217.0	1.501	0.750	CT	0.766	0.12	48.60			1972	82543
		0.80			217.0	1.199	0.604	CT	0.612	0.40	86.90			1972	82543
		0.80			217.0	1.498	0.754	CT	0.768	0.23	65.40			1972	82543
		0.80			217.0	1.201	0.606	CT	0.640	0.24	66.70			1972	82543
		0.80			217.0	1.504	0.693	CT	0.765	0.15	53.30			1972	82543
		0.80			217.0	1.500	0.757	CT	0.787	0.16	54.60			1972	82543
		0.80			217.0	1.199	0.602	CT	0.619	0.19	60.30			1972	82543
		0.80			217.0	1.500	0.749	CT	0.768	0.37	83.50			1972	82543
		0.80			217.0	1.504	0.692	CT	0.762	0.15	53.50			1972	82543
		0.80			217.0	1.199	0.603	CT	0.625	0.18	59.00			1972	82543
		0.80			217.0	1.200	0.607	CT	0.618	0.31	76.40			1972	82543
		0.80			217.0	1.199	0.603	CT	0.629	0.15	52.40			1972	82543
		0.80			217.0	1.497	0.750	CT	0.774	0.19	60.00			1972	82543
		0.80			217.0	1.199	0.600	CT	0.638	0.31	76.60			1972	82543
		0.80			217.0	1.199	0.606	CT	0.638	0.12	47.70			1972	82543
		0.80			217.0	1.500	0.758	CT	0.784	0.26	70.50			1972	82543
		0.80			217.0	1.505	0.759	CT	0.770	0.19	59.20			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR Cont'd	Plate Cont'd	0.80	R.T. Cont'd	L-T Cont'd	217.0	1.198	0.605	CT	0.625	0.42	89.00	Cont'd	Cont'd	1972	82543
		0.80			217.0	1.498	0.753	CT	0.781	0.13	50.00			1972	82543
		0.80			217.0	1.501	0.755	CT	0.746	0.16	55.60			1972	82543
		0.80			217.0	1.203	0.608	CT	0.621	0.27	71.60			1972	82543
		0.80			217.0	1.200	0.605	CT	0.621	0.21	62.30			1972	82543
		0.80			217.0	1.199	0.605	CT	0.630	0.20	60.80			1972	82543
		0.80			217.0	1.199	0.608	CT	0.635	0.20	61.60			1972	82543
		0.80			217.0	1.501	0.753	CT	0.773	0.13	50.30			1972	82543
		0.80			217.0	1.201	0.608	CT	0.615	0.19	60.70			1972	82543
		0.80			217.0	1.199	0.605	CT	0.630	0.33	78.40			1972	82543
		0.80			217.0	1.508	0.749	CT	0.779	0.19	59.50			1972	82543
		0.80			217.0	1.203	0.608	CT	0.619	0.42	88.90			1972	82543
		0.80			217.0	1.199	0.605	CT	0.630	0.18	57.80			1972	82543
		0.80			217.0	1.505	0.753	CT	0.765	0.14	50.60			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	120	L-T	211.0	1.499	0.757	CT	0.761	0.42	85.90	88.0	3.0	1972	82543
		0.80			211.0	1.500	0.757	CT	0.770	0.46	90.10			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	175	L-T	211.0	1.506	0.758	CT	0.779	0.44	88.10	89.5	2.1	1972	82543
		0.80			211.0	1.505	0.758	CT	0.775	0.47	91.90			1972	82543
		0.80			211.0	1.502	0.758	CT	0.784	0.44	88.60			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Plate	0.80	300	L-T	204.0	1.501	0.759	CT	0.782	0.47	88.10	86.6	3.2	1972	82543
		0.80			204.0	1.501	0.750	CT	0.770	0.41	82.90			1972	82543
		0.80			204.0	1.505	0.759	CT	0.771	0.47	88.80			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Forging	1.50	-65	L-T	225.0	1.502	0.756	CT	0.784	0.06	34.00	33.1	2.9	1972	82543
		1.50			225.0	1.502	0.756	CT	0.790	0.04	29.00			1972	82543
		0.80			225.0	1.500	0.750	CT	0.757	0.06	33.60			1972	82543
		0.80			225.0	1.500	0.749	CT	0.760	0.06	35.70			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Forging	0.80	-40	L-T	224.0	1.495	0.694	CT	0.753	0.09	41.60	40.7	1.3	1972	82543
		0.80			224.0	1.497	0.693	CT	0.776	0.08	39.80			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Forging	0.80	-20	L-T	222.0	1.498	0.750	CT	0.759	0.10	44.40	41.2	3.2	1972	82543
		0.80			222.0	1.497	0.749	CT	0.769	0.08	41.10			1972	82543
		0.80			222.0	1.494	0.749	CT	0.765	0.07	38.10			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Forging	1.50	0	L-T	220.0	1.502	0.750	CT	0.769	0.07	36.50	---	---	1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Forging	0.80	20	L-T	218.0	1.499	0.750	CT	0.761	0.11	40.00	43.4	3.0	1972	82543
		0.80			218.0	1.499	0.750	CT	0.757	0.10	44.60			1972	82543
		0.80			218.0	1.490	0.750	CT	0.751	0.11	45.60			1972	82543
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Forging	0.80	R.T.	L-T	214.0	1.198	0.608	CT	0.626	0.36	81.00	66.2	12.3	1972	82543
		0.80			214.0	1.502	0.749	CT	0.784	0.22	63.10			1972	82543
		0.80			214.0	1.202	0.602	CT	0.618	0.16	55.10			1972	82543
		0.80			214.0	1.200	0.607	CT	0.618	0.24	66.10			1972	82543
		0.80			214.0	1.200	0.607	CT	0.625	0.34	78.60			1972	82543
		0.80			214.0	1.199	0.602	CT	0.618	0.17	55.80			1972	82543
		0.80			214.0	1.199	0.607	CT	0.623	0.29	73.10			1972	82543
		0.80			214.0	1.503	0.692	CT	0.775	0.51	96.30			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * (K_{Ic}/TYS)² (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR Cont'd	Forging Cont'd	0.80	R.T. Cont'd	L-T Cont'd	214.0	1.198	0.695	CT	0.628	0.14	50.30	Cont'd	Cont'd	1972	82543
		0.80			214.0	1.201	0.603	CT	0.619	0.28	72.30			1972	82543
		0.80			214.0	1.200	0.607	CT	0.634	0.34	79.50			1972	82543
		0.80			214.0	1.202	0.602	CT	0.620	0.15	52.00			1972	82543
		0.80			214.0	1.199	0.602	CT	0.621	0.30	73.60			1972	82543
		0.80			214.0	1.500	0.750	CT	0.766	0.31	75.50			1972	82543
		0.80			214.0	1.498	0.696	CT	0.747	0.18	57.40			1972	82543
		0.80			214.0	1.195	0.606	CT	0.634	0.49	94.40			1972	82543
		0.80			214.0	1.203	0.604	CT	0.627	0.22	64.20			1972	82543
		0.80			214.0	1.199	0.603	CT	0.618	0.34	78.40			1972	82543
		0.80			214.0	1.499	0.749	CT	0.755	0.20	59.80			1972	82543
		0.80			214.0	1.201	0.599	CT	0.623	0.29	73.20			1972	82543
		0.80			214.0	1.498	0.757	CT	0.754	0.20	60.60			1972	82543
		0.80			214.0	1.200	0.604	CT	0.620	0.35	79.70			1972	82543
		0.80			214.0	1.499	0.750	CT	0.762	0.18	57.90			1972	82543
		0.80			214.0	1.198	0.607	CT	0.645	0.39	84.10			1972	82543
		0.80			214.0	1.202	0.605	CT	0.631	0.26	68.70			1972	82543
		0.80			214.0	1.202	0.603	CT	0.624	0.37	82.30			1972	82543
		0.80			214.0	1.201	0.603	CT	0.615	0.15	53.10			1972	82543
		0.80			214.0	1.200	0.606	CT	0.627	0.20	61.00			1972	82543
		0.80			214.0	1.499	0.752	CT	0.760	0.24	66.50			1972	82543
		0.80			214.0	1.200	0.605	CT	0.620	0.14	51.20			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi • √in.)	K_{Ic} MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR Cont'd	Forging Cont'd	0.80	R.T. Cont'd	L-T Cont'd	214.0	1.502	0.750	CT	0.762	0.17	55.50	Cont'd	Cont'd	1972	82543
		0.80			214.0	1.499	0.750	CT	0.766	0.20	61.00			1972	82543
		0.80			214.0	1.502	0.692	CT	0.767	0.48	93.60			1972	82543
		0.80			214.0	1.200	0.603	CT	0.631	0.24	65.70			1972	82543
		0.80			214.0	1.200	0.607	CT	0.631	0.25	67.60			1972	82543
		0.80			214.0	1.497	0.694	CT	0.761	0.20	60.10			1972	82543
		0.80			214.0	1.197	0.607	CT	0.635	0.20	61.20			1972	82543
		0.80			214.0	1.501	0.750	CT	0.769	0.33	77.60			1972	82543
		0.80			214.0	1.499	0.753	CT	0.756	0.23	64.40			1972	82543
		0.80			214.0	1.202	0.603	CT	0.626	0.15	52.90			1972	82543
		0.80			214.0	1.198	0.608	CT	0.598	0.32	76.30			1972	82543
		0.80			214.0	1.200	0.605	CT	0.620	0.14	51.30			1972	82543
		0.80			214.0	1.199	0.608	CT	0.617	0.24	65.60			1972	82543
		0.80			214.0	1.201	0.603	CT	0.623	0.16	54.60			1972	82543
		0.80			214.0	1.502	0.750	CT	0.775	0.16	54.50			1972	82543
		0.80			214.0	1.200	0.599	CT	0.618	0.23	65.20			1972	82543
		0.80			214.0	1.200	0.605	CT	0.626	0.20	60.40			1972	82543
		0.80			214.0	1.497	0.750	CT	0.751	0.16	53.60			1972	82543
		0.80			214.0	1.200	0.604	CT	0.622	0.27	70.00			1972	82543
		1.50			214.0	1.499	0.756	CT	0.866	0.08	39.30			1972	82543
		0.80			214.0	1.199	0.603	CT	0.617	0.34	78.40			1972	82543
		0.80			214.0	1.201	0.603	CT	0.633	0.20	60.80			1972	82543
		0.80			214.0	1.199	0.603	CT	0.623	0.17	56.20			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_Q/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_Q (Ksi $\cdot \sqrt{in.}$)	K_Q MEAN	STAN DEV		
1650F AUS-BAY QUENCH 975F SQ 400F 1000F 2+2HR	Forging	0.80	175	L-T	208.0	1.498	0.750	CT	0.757	0.32	74.30	77.2	3.0	1972	82543
		0.80			208.0	1.500	0.750	CT	0.762	0.37	80.30			1972	82543
		0.80			208.0	1.504	0.750	CT	0.771	0.34	77.10			1972	82543
1675F AC 1575F OQ 400F 2HR 1100F 2HR (RC 42.5)	Plate	1.00	R.T.	---	---	1.999	1.008	CT	1.105	0.42	78.30	77.1	1.0	1973	85883 (1)
		1.00			---	2.002	1.006	CT	1.069	0.40	76.50			1973	85883 (1)
		1.00			---	1.997	1.007	CT	1.075	0.42	77.60			1973	85883 (1)
		1.00			---	1.995	1.008	CT	1.076	0.40	76.20			1973	85883 (1)
1675F AC 1575F OQ 400F 2HR 500F 2HR (RC 50)	Plate	1.00	R.T.	---	---	2.001	1.007	CT	1.031	0.05	34.00	34.5	1.2	1973	85883 (2)
		1.00			---	1.999	1.007	CT	1.046	0.04	33.00			1973	85883 (2)
		1.00			---	1.996	1.007	CT	1.032	0.05	35.10			1973	85883 (2)
		1.00			---	1.996	1.007	CT	1.059	0.05	35.80			1973	85883 (2)
1675F AC 1575F OQ 400F 2HR 800F 2HR (RC 46.5)	Plate	1.00	R.T.	---	---	1.995	1.006	CT	1.139	0.15	53.50	53.7	1.6	1973	85883 (3)
		1.00			---	1.995	1.006	CT	1.116	0.16	55.90			1973	85883 (3)
		1.00			---	1.992	1.006	CT	1.097	0.14	52.20			1973	85883 (3)
		1.00			---	1.996	1.006	CT	1.118	0.15	53.10			1973	85883 (3)
1700F 1 HR FC TO 960F OQ AT 150F AC 1000F 2+2HR	Billet	7.00	R.T.	L-T	215.0	2.500	1.000	CT	1.400	0.31	75.70	80.3	4.3	1972	84277
		7.00			215.0	2.500	1.000	CT	1.400	0.38	84.30			1972	84277
		7.00			215.0	2.500	1.000	CT	1.400	0.35	80.80			1972	84277

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1700F 1 HR OQ 1025F 2+2HR	Billet	7.00	R.T.	L-T	214.0	2.500	1.000	CT	1.400	0.33	78.40	77.3	2.6	1972	84277
		7.00			214.0	2.500	1.000	CT	1.400	0.36	81.10			1972	84277
		7.00			214.0	2.500	1.000	CT	1.400	0.33	78.10			1972	84277
		10.00			216.0	2.500	1.000	CT	1.400	0.30	75.30			1972	84277
		10.00			216.0	2.500	1.000	CT	1.400	0.32	77.10			1972	84277
		10.00			216.0	2.500	1.000	CT	1.400	0.29	73.70			1972	84277
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	0.80	-65	L-T	228.0	1.502	0.759	CT	0.774	0.13	51.40	51.4	6.0	1972	82543
		1.50			228.0	1.502	0.750	CT	0.759	0.10	46.40			1972	82543
		0.80			228.0	1.506	0.759	CT	0.774	0.15	56.40			1972	82543
		0.80			228.0	1.499	0.749	CT	0.755	0.16	58.50			1972	82543
		0.80			228.0	1.502	0.749	CT	0.748	0.13	52.80			1972	82543
		1.50			228.0	1.502	0.755	CT	0.763	0.11	48.70			1972	82543
		1.50			228.0	1.502	0.750	CT	0.759	0.10	46.40			1972	82543
		0.80			228.0	1.501	0.759	CT	0.780	0.17	59.80			1972	82543
		1.50			228.0	1.506	0.750	CT	0.753	0.09	42.20			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	1.50	-40	L-T	227.0	1.503	0.749	CT	0.768	0.10	44.60	45.4	2.2	1972	82543
		1.50			227.0	1.499	0.754	CT	0.772	0.11	47.90			1972	82543
		1.50			227.0	1.501	0.750	CT	0.768	0.09	43.70			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	1.50	-20	L-T	226.0	1.501	0.750	CT	0.763	0.12	50.40	62.4	12.0	1972	82543
		0.80			226.0	1.504	0.754	CT	0.773	0.27	74.00			1972	82543
		1.50			226.0	1.502	0.752	CT	0.779	0.14	54.00			1972	82543
		0.80			226.0	1.500	0.755	CT	0.759	0.28	75.20			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_Q/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_Q (Ksi * √in.)	K_Q MEAN	STAN DEV		
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR Cont'd	Plate Cont'd	0.80	-20 Cont'd	L-T Cont'd	226.0	1.504	0.749	CT	0.756	0.24	69.30	Cont'd	Cont'd	1972	82543
		0.80			226.0	1.502	0.755	CT	0.760	0.23	67.90			1972	82543
		1.50			226.0	1.499	0.749	CT	0.754	0.10	45.90			1972	82543
		0.80			226.0	1.506	0.749	CT	0.756	0.27	74.40			1972	82543
		1.50			226.0	1.501	0.750	CT	0.763	0.12	50.40			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	1.50	0	L-T	224.0	1.502	0.750	CT	0.768	0.14	53.60	55.0	1.5	1972	82543
		1.50			224.0	1.499	0.755	CT	0.799	0.16	56.50			1972	82543
		1.50			225.0	1.503	0.750	CT	0.767	0.15	54.80			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	1.50	20	L-T	222.0	1.500	0.755	CT	0.788	0.17	59.10	76.5	13.5	1972	82543
		0.80			222.0	1.504	0.755	CT	0.770	0.35	83.70			1972	82543
		0.80			222.0	1.501	0.753	CT	0.753	0.37	85.70			1972	82543
		1.50			222.0	1.501	0.750	CT	0.778	0.17	58.40			1972	82543
		0.80			222.0	1.502	0.754	CT	0.770	0.41	89.90			1972	82543
		1.50			222.0	1.500	0.748	CT	0.762	0.26	71.30			1972	82543
		0.80			222.0	1.504	0.754	CT	0.765	0.39	87.20			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	1.50	40	L-T	220.0	1.501	0.750	CT	0.790	0.22	66.10	70.4	8.8	1972	82543
		1.50			220.0	1.499	0.752	CT	0.779	0.21	64.50			1972	82543
		1.50			220.0	1.501	0.749	CT	0.767	0.33	80.50			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	0.80	R.T.	L-T	217.0	1.504	0.757	CT	0.790	0.50	97.00	92.0	8.2	1972	82543
		0.80			217.0	1.502	0.757	CT	0.779	0.47	94.20			1972	82543
		0.80			217.0	1.506	0.752	CT	0.759	0.44	90.60			1972	82543
		0.80			217.0	1.498	0.756	CT	0.773	0.50	97.20			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_c/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_c (Ksi • $\sqrt{in.}$)	K_c MEAN	STAN DEV		
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR Cont'd	Plate Cont'd	0.80	R.T. Cont'd	L-T Cont'd	217.0	1.500	0.749	CT	0.755	0.48	95.10	Cont'd	Cont'd	1972	82543
		1.50			217.0	1.499	0.758	CT	0.769	0.45	92.60			1972	82543
		0.80			217.0	1.503	0.756	CT	0.755	0.49	96.30			1972	82543
		0.80			217.0	1.202	0.607	CT	0.624	0.46	92.80			1972	82543
		1.50			217.0	1.497	0.757	CT	0.781	0.32	77.40			1972	82543
		0.80			217.0	1.498	0.692	CT	0.747	0.47	93.90			1972	82543
		0.80			217.0	1.539	0.752	CT	0.817	0.49	96.50			1972	82543
		0.80			217.0	1.201	0.607	CT	0.621	0.44	91.40			1972	82543
		0.80			217.0	1.498	0.694	CT	0.759	0.49	96.10			1972	82543
		0.80			217.0	1.501	0.757	CT	0.759	0.52	99.10			1972	82543
		0.80			217.0	1.501	0.757	CT	0.773	0.48	95.40			1972	82543
		0.80			217.0	1.500	0.753	CT	0.754	0.46	93.20			1972	82543
		0.80			217.0	1.502	0.749	CT	0.759	0.45	91.90			1972	82543
		1.50			217.0	1.497	0.758	CT	0.782	0.27	70.80			1972	82543
		0.80			217.0	1.503	0.758	CT	0.766	0.45	92.50			1972	82543
		0.80			217.0	1.504	0.750	CT	0.791	0.49	96.30			1972	82543
		0.80			217.0	1.502	0.756	CT	0.786	0.37	83.30			1972	82543
		0.80			217.0	1.496	0.757	CT	0.803	0.53	100.50			1972	82543
		0.80			217.0	1.497	0.758	CT	0.776	0.48	94.70			1972	82543
		1.50			217.0	1.503	0.758	CT	0.779	0.45	91.70			1972	82543
		0.80			217.0	1.495	0.752	CT	0.767	0.44	91.00			1972	82543
		0.80			217.0	1.499	0.749	CT	0.761	0.55	101.70			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR Cont'd	Plate Cont'd	0.80	R.T. Cont'd	L-T Cont'd	217.0	1.500	0.758	CT	0.792	0.44	91.20	Cont'd	Cont'd	1972	82543
		0.80			217.0	1.500	0.751	CT	0.756	0.51	98.20			1972	82543
		1.50			217.0	1.504	0.750	CT	0.765	0.22	64.10			1972	82543
		0.80			217.0	1.495	0.757	CT	0.802	0.47	94.20			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	1.50	175	L-T	211.0	1.501	0.752	CT	0.785	0.48	92.70	92.3	3.1	1972	82543
		1.50			211.0	1.501	0.750	CT	0.763	0.51	95.20			1972	82543
		1.50			211.0	1.500	0.749	CT	0.760	0.44	89.20			1972	82543
		0.80			211.0	1.499	0.752	CT	0.752	0.45	89.30			1972	82543
		0.80			211.0	1.506	0.753	CT	0.761	0.46	90.70			1972	82543
		0.80			211.0	1.501	0.754	CT	0.779	0.52	96.50			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Plate	1.50	300	L-T	204.0	1.499	0.754	CT	0.790	0.50	91.30	88.6	2.5	1972	82543
		1.50			204.0	1.499	0.750	CT	0.779	0.45	86.40			1972	82543
		1.50			204.0	1.499	0.749	CT	0.758	0.47	88.00			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Forging	1.50	-65	L-T	225.0	1.500	0.751	CT	0.789	0.11	47.50	45.5	4.5	1972	82543
		1.50			225.0	1.501	0.749	CT	0.762	0.14	52.80			1972	82543
		1.50			225.0	1.502	0.751	CT	0.783	0.11	47.30			1972	82543
		1.50			225.0	1.501	0.752	CT	0.760	0.09	41.90			1972	82543
		1.50			225.0	1.501	0.752	CT	0.760	0.09	42.60			1972	82543
		1.50			225.0	1.500	0.753	CT	0.758	0.08	41.10			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Forging	1.50	-20	L-T	222.0	1.501	0.750	CT	0.752	0.16	55.70	58.3	10.3	1972	82543
		1.50			222.0	1.498	0.751	CT	0.765	0.12	49.60			1972	82543
		1.50			222.0	1.501	0.750	CT	0.777	0.25	69.60			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
		1.50			218.0	1.500	0.750	CT	0.778	0.31	76.50			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Forging	1.50	20	L-T	218.0	1.499	0.750	CT	0.741	0.19	60.00	66.5	8.8	1972	82543
		1.50			218.0	1.503	0.752	CT	0.770	0.21	63.10			1972	82543
		0.80			214.0	1.498	0.757	CT	0.767	0.53	98.50			1972	82543
		0.80			214.0	1.501	0.750	CT	0.759	0.46	91.80			1972	82543
		0.80			214.0	1.503	0.750	CT	0.778	0.45	90.40			1972	82543
		0.80			214.0	1.501	0.748	CT	0.755	0.57	102.40			1972	82543
		0.80			214.0	1.494	0.757	CT	0.758	0.47	93.00			1972	82543
		0.80			214.0	1.500	0.750	CT	0.771	0.57	102.00			1972	82543
		0.80			214.0	1.499	0.757	CT	0.760	0.49	95.30			1972	82543
		1.50			214.0	1.501	0.752	CT	0.765	0.39	84.90			1972	82543
		1.50			214.0	1.498	0.750	CT	0.762	0.53	98.50			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Forging	0.80	R.T.	L-T	214.0	1.498	0.749	CT	0.759	0.45	91.00	95.2	6.4	1972	82543
		0.80			214.0	1.500	0.756	CT	0.782	0.58	103.10			1972	82543
		0.80			214.0	1.501	0.749	CT	0.789	0.47	92.60			1972	82543
		0.80			214.0	1.499	0.750	CT	0.762	0.47	93.00			1972	82543
		1.50			214.0	1.503	0.753	CT	0.759	0.46	92.00			1972	82543
		0.80			214.0	1.500	0.751	CT	0.814	0.50	95.80			1972	82543
		0.80			214.0	1.499	0.750	CT	0.753	0.47	92.80			1972	82543
		1.50			214.0	1.501	0.751	CT	0.757	0.48	93.60			1972	82543
		0.80			214.0	1.500	0.749	CT	0.759	0.46	91.60			1972	82543
		1.50			214.0	1.501	0.752	CT	0.774	0.44	89.70			1972	82543

TABLE 3.30.2.1 (CONTINUED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_Q (Ksi $\cdot$ $\sqrt{in.}$)	K_Q MEAN	STAN DEV		
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR Cont'd	Forging Cont'd	0.80	R.T. Cont'd	L-T Cont'd	214.0	1.499	0.750	CT	0.753	0.47	92.80	Cont'd	Cont'd	1972	82543
		1.50			214.0	1.500	0.752	CT	0.763	0.46	91.50			1972	82543
		0.80			214.0	1.497	0.756	CT	0.762	0.49	94.30			1972	82543
		0.80			214.0	1.500	0.750	CT	0.768	0.39	84.80			1972	82543
		0.80			214.0	1.504	0.748	CT	0.743	0.58	102.90			1972	82543
		0.80			214.0	1.501	0.749	CT	0.779	0.52	97.60			1972	82543
		0.80			214.0	1.501	0.750	CT	0.758	0.51	96.50			1972	82543
		0.80			214.0	1.497	0.750	CT	0.755	0.53	98.60			1972	82543
		0.80			214.0	1.500	0.752	CT	0.769	0.56	101.70			1972	82543
		0.80			214.0	1.500	0.748	CT	0.757	0.56	100.90			1972	82543
		1.50			214.0	1.504	0.751	CT	0.770	0.39	84.90			1972	82543
		0.80			214.0	1.497	0.748	CT	0.774	0.65	109.40			1972	82543
		0.80			214.0	1.500	0.751	CT	0.781	0.57	102.20			1972	82543
		0.80			214.0	1.493	0.748	CT	0.758	0.60	105.30			1972	82543
		1.50			214.0	1.503	0.751	CT	0.771	0.36	81.70			1972	82543
1700F AUS-BAY QUENCH 975F OQ 140F 1000F 2+2 HR	Forging	1.50	175	L-T	208.0	1.501	0.756	CT	0.778	0.57	99.50	97.5	1.7	1972	82543
		1.50			208.0	1.500	0.755	CT	0.762	0.54	96.70			1972	82543
		1.50			208.0	1.501	0.756	CT	0.774	0.54	96.30			1972	82543
1725F 1 HR AC 1650F 1 HR FC TO 960F SQ 350F 0.5 HR AC 1025F 2+2 HR	Billet	7.00	R.T.	L-T	221.0	2.500	1.000	CT	1.400	0.21	63.70	75.1	10.1	1972	84277
		7.00			221.0	2.500	1.000	CT	1.400	0.32	78.80			1972	84277
		7.00			221.0	2.500	1.000	CT	1.400	0.35	82.80			1972	84277

TABLE 3.30.2.1 (CONCLUDED)

ALLOY STEEL D6AC K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} $(Ksi \cdot \sqrt{in.})$	K_{Ic} MEAN	STAN DEV	DATE	REFER
1725F 1 HR AC 1700F 1 HR OQ 1000F 1 HR OQ 1000F 1 HR 1015F 1 HR	Billet	7.00	R.T.	L-T	213.0	2.500	1.000	CT	1.400	0.35	80.10	77.2	2.7	1972	84277
		7.00			213.0	2.500	1.000	CT	1.400	0.31	74.70			1972	84277
		7.00			213.0	2.500	1.000	CT	1.400	0.33	76.90			1972	84277
1725F 1 HR AC 1700F 1 HR OQ 1025F 2+2 HR	Billet	7.00	R.T.	L-T	213.0	2.500	1.000	CT	1.400	0.31	75.50	74.4	6.2	1972	84277
		7.00			213.0	2.500	1.000	CT	1.400	0.30	73.20			1972	84277
		7.00			213.0	2.500	1.000	CT	1.400	0.38	83.10			1972	84277
		10.00			217.0	2.500	1.000	CT	1.400	0.22	64.60			1972	84277
		10.00			217.0	2.500	1.000	CT	1.400	0.27	71.90			1972	84277
		10.00			217.0	2.500	1.000	CT	1.400	0.32	77.90			1972	84277
1725F 1 HR AC 1700F 1 HR OQ 1100F 2+2 HR	Billet	7.00	R.T.	L-T	200.0	2.500	1.000	CT	1.400	0.60	97.70	101.2	6.1	1972	84277
		7.00			200.0	2.500	1.000	CT	1.400	0.52	91.20			1972	84277
		7.00			200.0	2.500	1.000	CT	1.400	0.74	109.00			1972	84277
		10.00			205.0	2.500	1.000	CT	1.400	0.65	104.00			1972	84277
		10.00			205.0	2.500	1.000	CT	1.400	0.63	103.00			1972	84277
		10.00			205.0	2.500	1.000	CT	1.400	0.62	102.00			1972	84277
HEAT TREATED TO 46 RC HARDNESS	Plate	...	R.T.	T-L	206.0	1.400	0.700	NB	0.717	0.45	87.00	85.8	1.8	1971	84029
		...			206.0	1.401	0.700	NB	0.711	0.42	84.50			1971	84029

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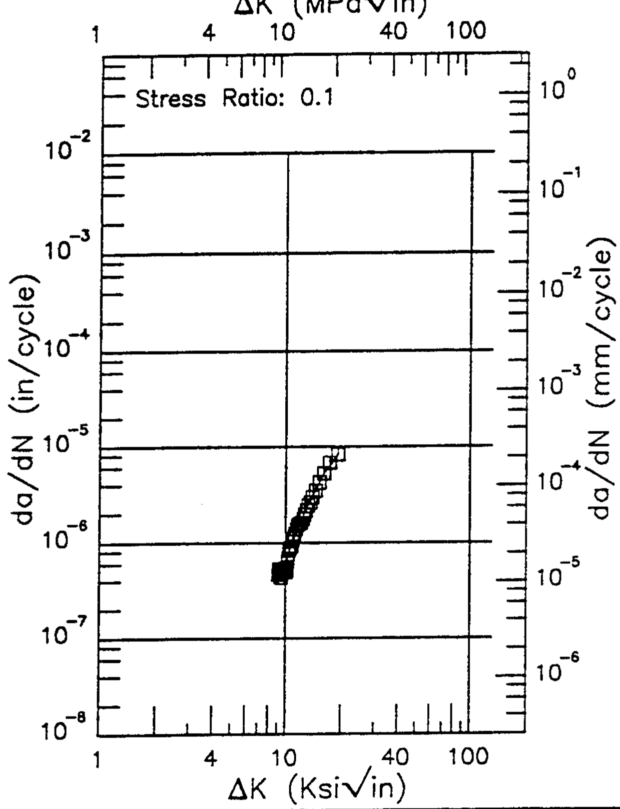
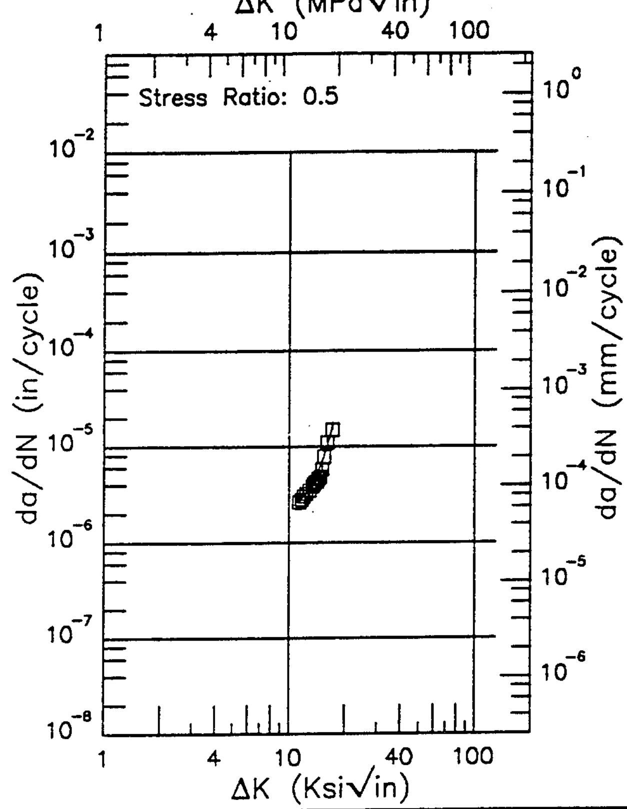
R D6AC

Condition/Ht: 1650F A–BQ AT 975F SQ AT 375F 1000F 2+2HR

Form: 1.8 in. Forging	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L–T	Specimen Thk: 0.507 in.
Frequency: 1 Hz	Specimen Width: 2.5 in.
Environment: JP4; RT	Ref: 82543



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.06 (min)	0.395
10.	0.646
13.	2.26
16.	5.16
19.10 (max)	8.45



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.31 (min)	2.76
13.	3.46
16.	9.50
17.07 (max)	16.1

RMS % Error	Life Prediction Ratio Summary
12.05	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
11.14	0. .5 .8 1.25 2.

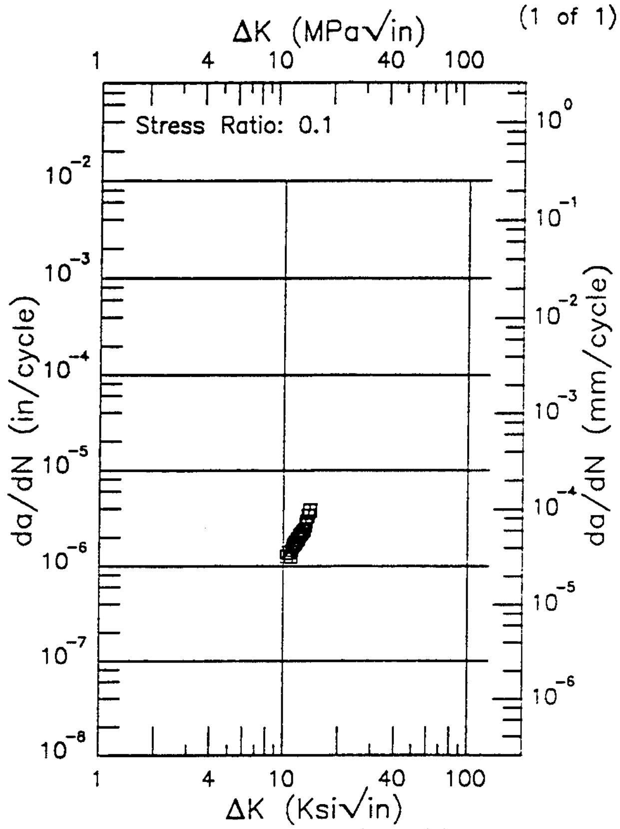
Figure 3.30.3.1.1

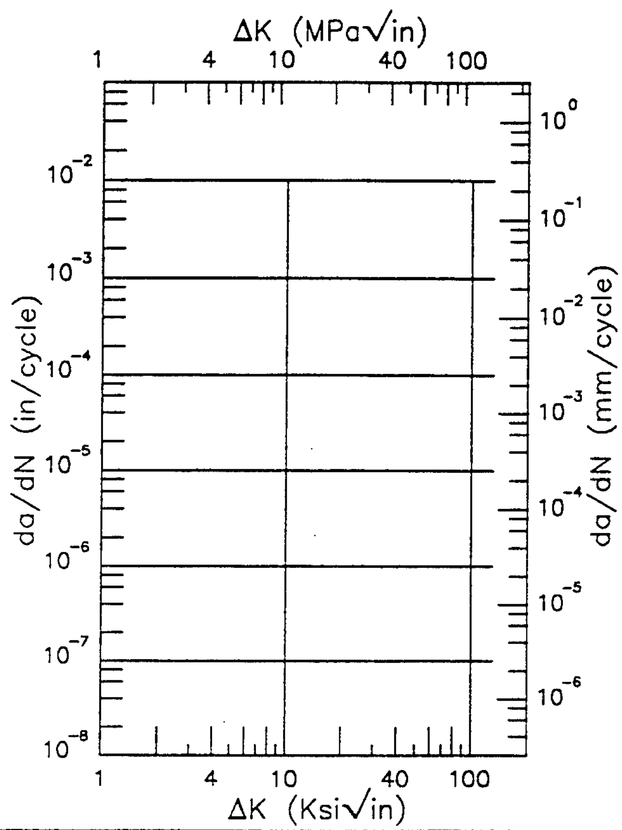
D6AC

R

Condition/Ht: 1650F A-BQ AT 975F SQ AT 375F 1000F 2+2HR

Form: 1.8 in. Forging	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.507 in.
Frequency: 3 Hz	Specimen Width: 2.5 in.
Environment: JP4; RT	Ref: 82543





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
10.31 (min)	1.26
13.	2.58
13.87 (max)	3.69

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
5.49	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.30.3.1.2

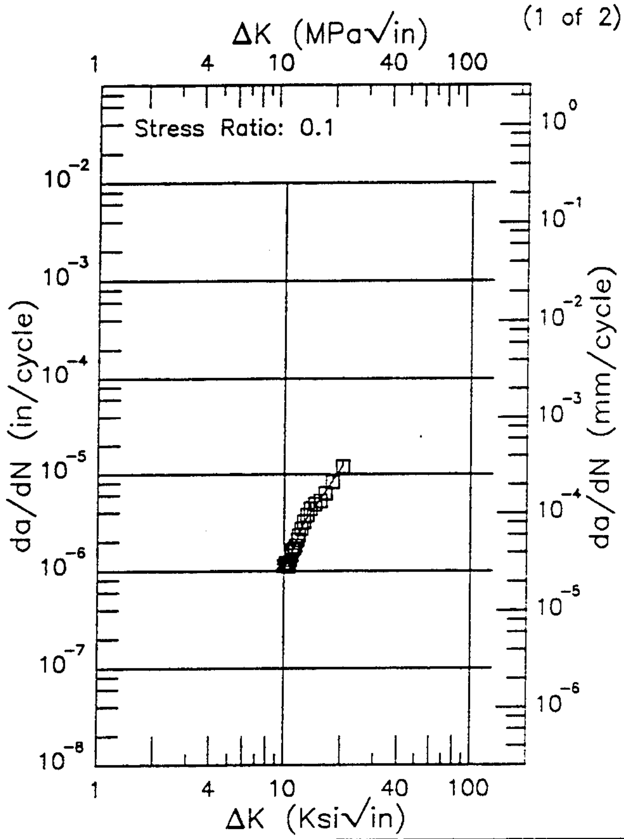
D6AC

R

Condition/Ht: 1650F A-BQ AT 975F SQ AT 375F 1000F 2+2HR
Form: 1.8 in. Forging
Specimen Type: CT
Orientation: L-T
Frequency: 1 Hz
Environment: DIST WATER; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.506 – 0.507 in.
Specimen Width: 2.5 in.
Ref: 82543

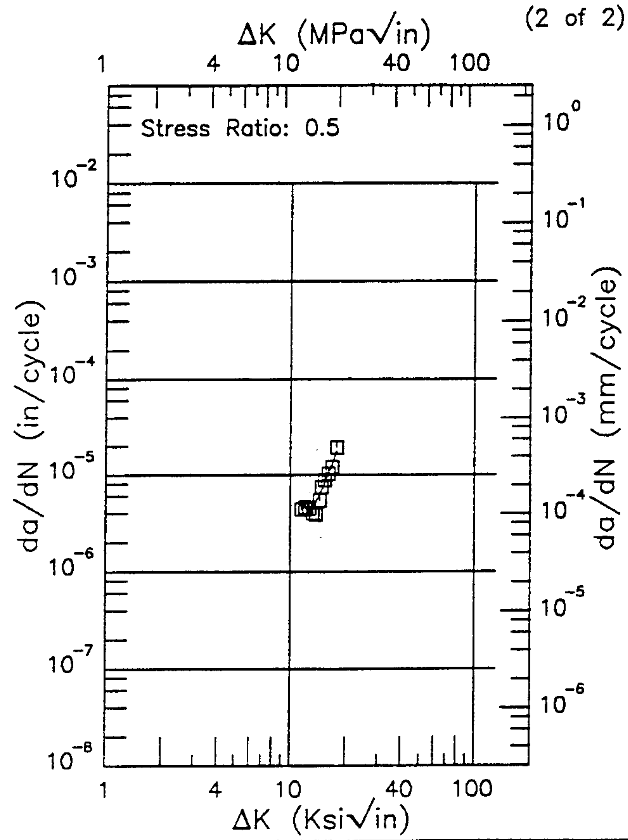
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.88 (min)	0.960
10.	1.02
13.	3.30
16.	6.13
20.	11.5
20.23 (max)	12.1

RMS % Error	Life Prediction Ratio Summary
7.82	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.47 (min)	4.85
13.	4.09
16.	9.69
17.89 (max)	17.9

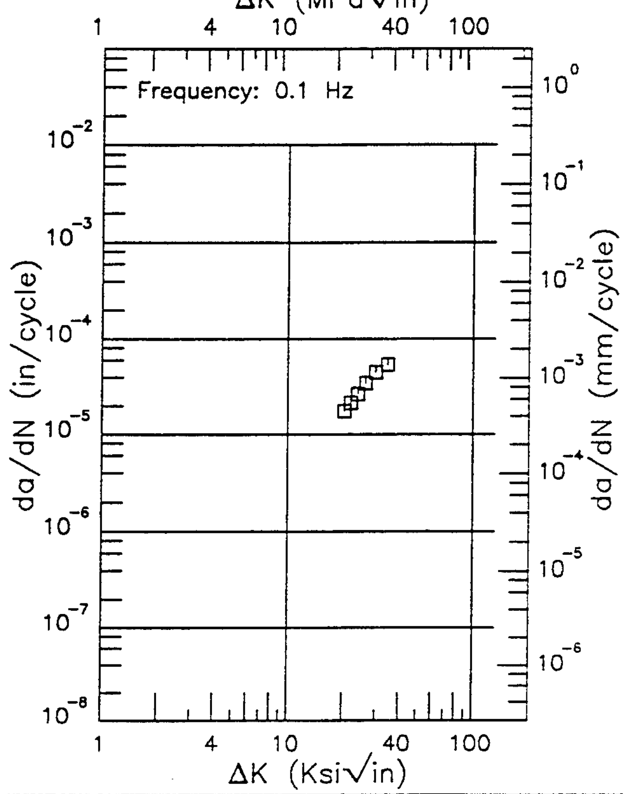
RMS % Error	Life Prediction Ratio Summary
11.63	0. .5 .8 1.25 2.

Figure 3.30.3.1.3

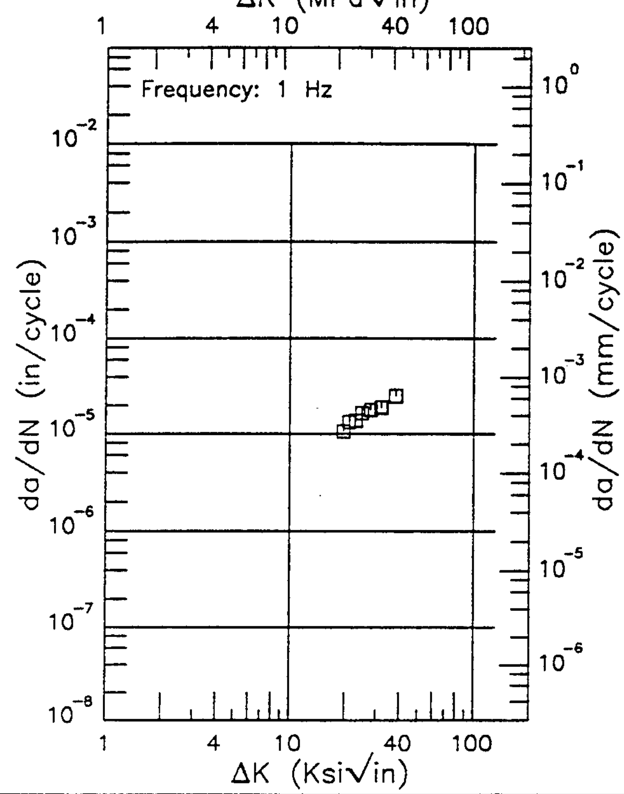
Condition/Ht: 1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR

Form: 0.8 in. Plate	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.75 in.
Stress Ratio: 0.08	Specimen Width: 5 in.
Environment: DIST WATER; RT	Ref: 82543

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.30.3.1.4

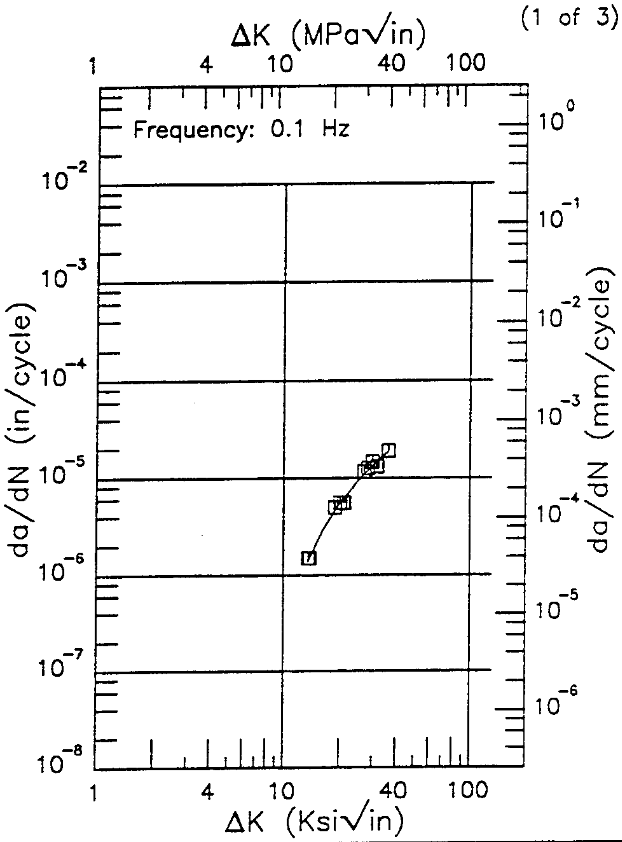
D6AC

F

Condition/Ht: 1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR

Form: 0.8 in. Plate	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.75 in.
Stress Ratio: 0.09	Specimen Width: 5 in.
Environment: DRY AIR; RT	Ref: 82543

(1 of 3)



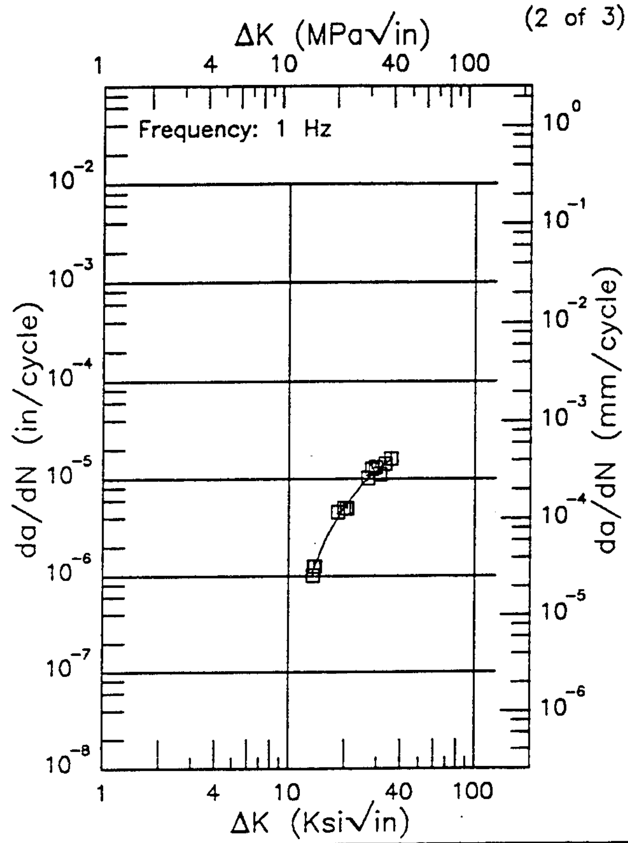
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.47 (min)	1.39
16.	2.79
20.	5.58
25.	9.39
30.	13.3
35.	17.5
36.15 (max)	18.6

RMS % Error 7.36

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.43 (min)	1.07
16.	2.45
20.	5.24
25.	8.84
30.	12.2
35.	15.6
35.22 (max)	15.7

RMS % Error 9.28

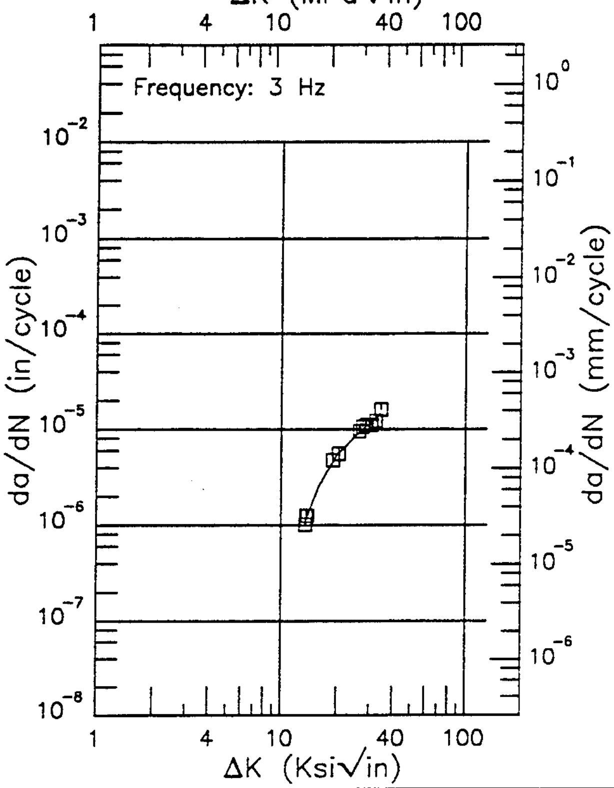
Life Prediction Ratio Summary

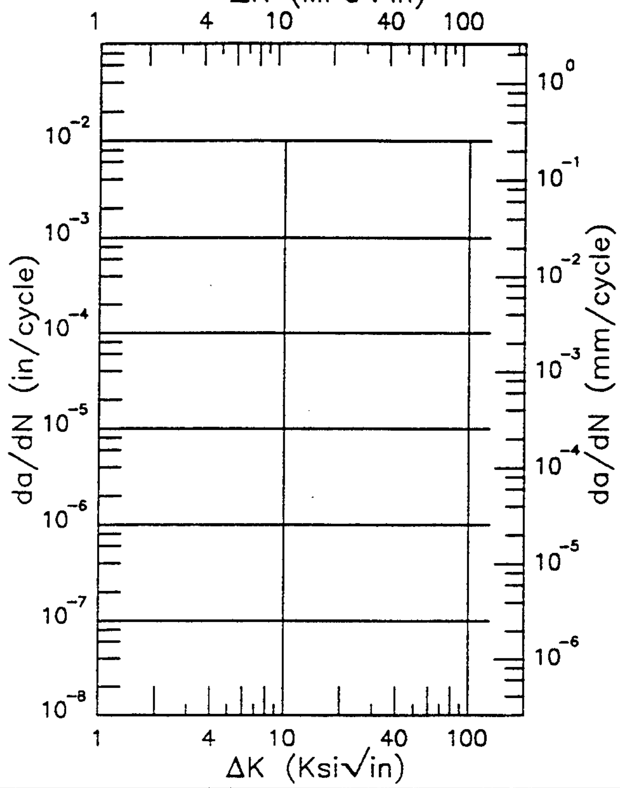
0. .5 .8 1.25 2.

Figure 3.30.3.1.5

Condition/Ht: 1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.09
Environment: DRY AIR; RT
Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.75 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
13.52 (min)	1.11
16.	2.59
20.	5.43
25.	8.61
30.	11.5
34.37 (max)	14.4

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
6.40	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.30.3.1.5 (Concluded)

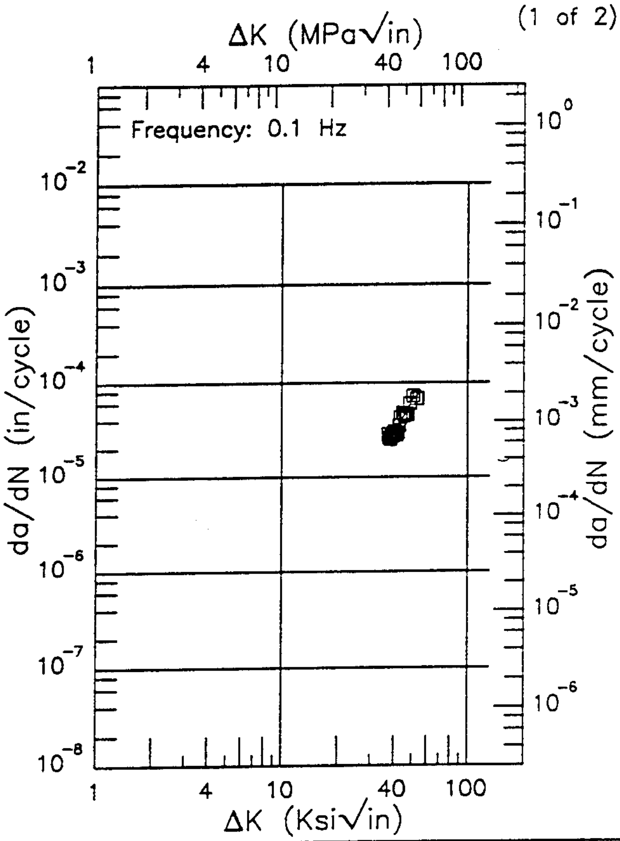
D6AC

F

Condition/Ht: 1650F A–BQ AT 975F SQ AT 400F 1000F 2+2HR
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.1
Environment: LAB AIR; RT

Yield Strength: 217 – 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.69 in.
Specimen Width: 1.5 in.
Ref: 82543

(1 of 2)



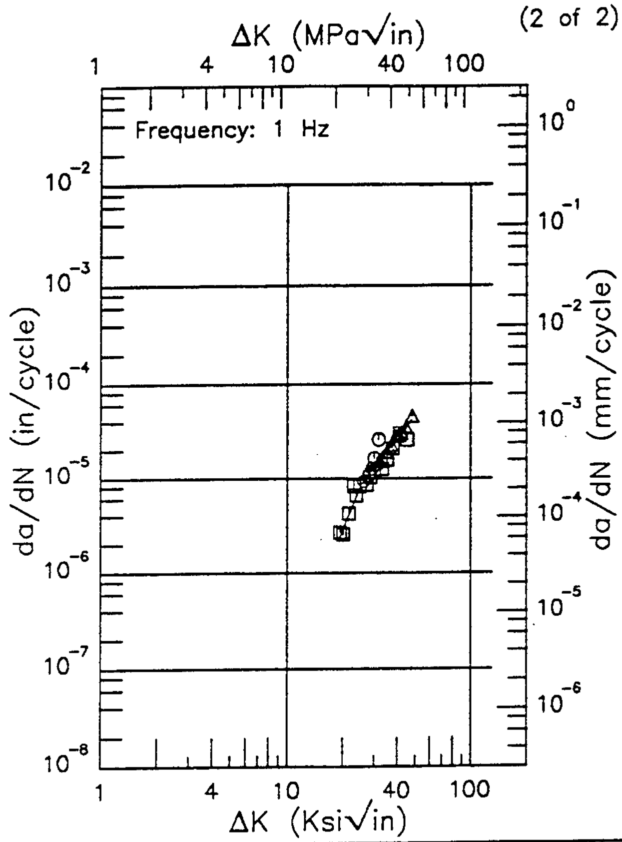
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
37.20 (min)	25.7
40.	28.5
50.	65.2
52.74 (max)	71.2

RMS % Error 7.75

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.32 (min)	2.28
20.	2.85
25.	8.21
30.	13.8
35.	19.1
40.	25.5
47.75 (max)	42.0

RMS % Error 18.61

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.30.3.1.6

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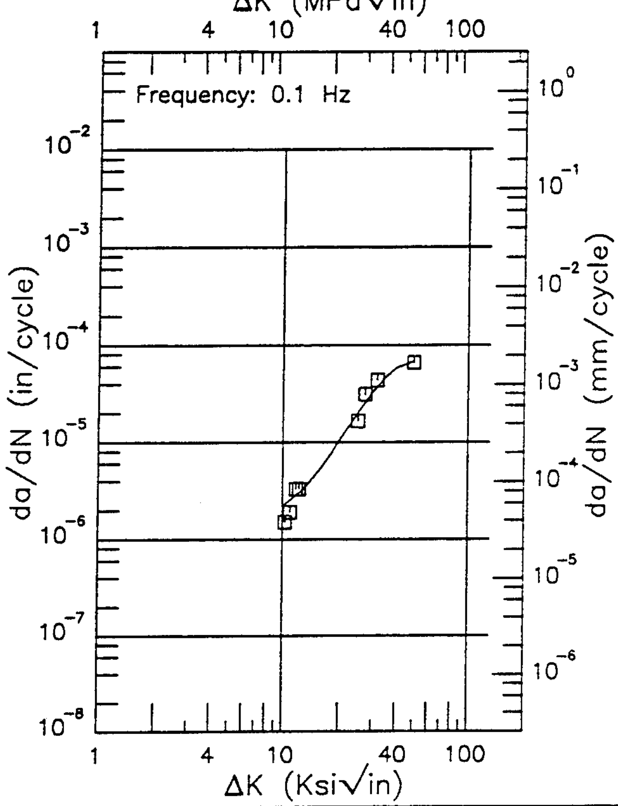
D6AC

F

Condition/Ht: 1650F A–BQ AT 975F SQ AT 400F 1000F 2+2HR

Form: 0.8 in. Plate	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L–T	Specimen Thk: 0.751 in.
Stress Ratio: 0.1	Specimen Width: 5 in.
Environment: JP4; RT	Ref: 82543

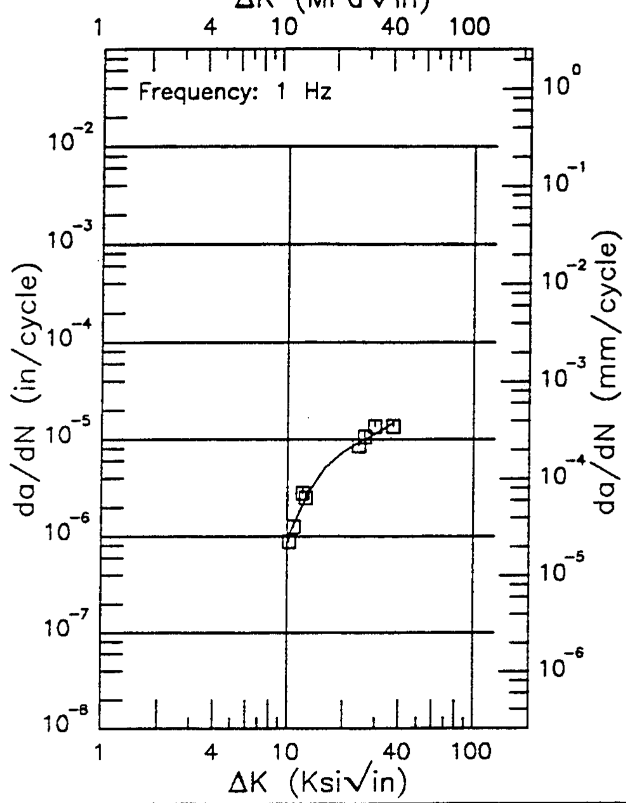
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.28 (min)	2.31
13.	3.32
16.	5.48
20.	10.4
25.	20.2
30.	33.1
35.	46.7
40.	58.2
49.58 (max)	67.9

RMS % Error	Life Prediction Ratio Summary
20.08	0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.19 (min)	1.01
13.	2.86
16.	5.05
20.	7.44
25.	9.60
30.	11.5
35.	13.7
36.95 (max)	14.8

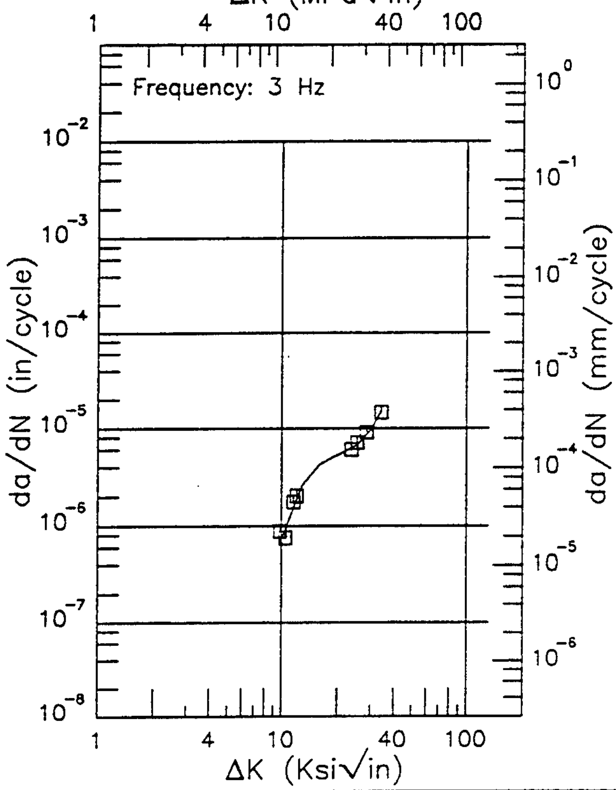
RMS % Error	Life Prediction Ratio Summary
15.23	0. .5 .8 1.25 2.

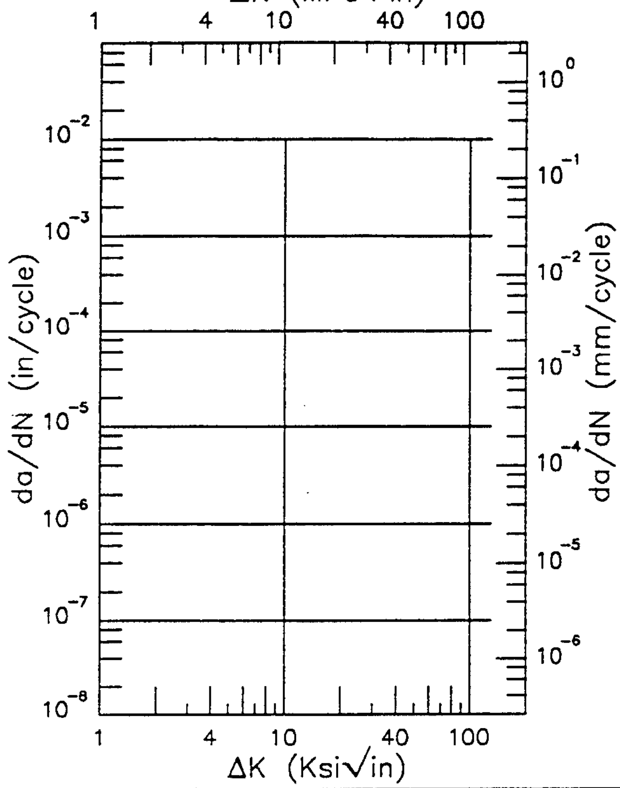
Figure 3.30.3.1.7

Condition/Ht: 1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.1
Environment: JP4; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.751 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
9.80 (min)	0.639
10.	0.736
13.	2.64
16.	4.21
20.	5.31
25.	6.64
30.	9.58
34.21 (max)	15.1

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
16.72	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

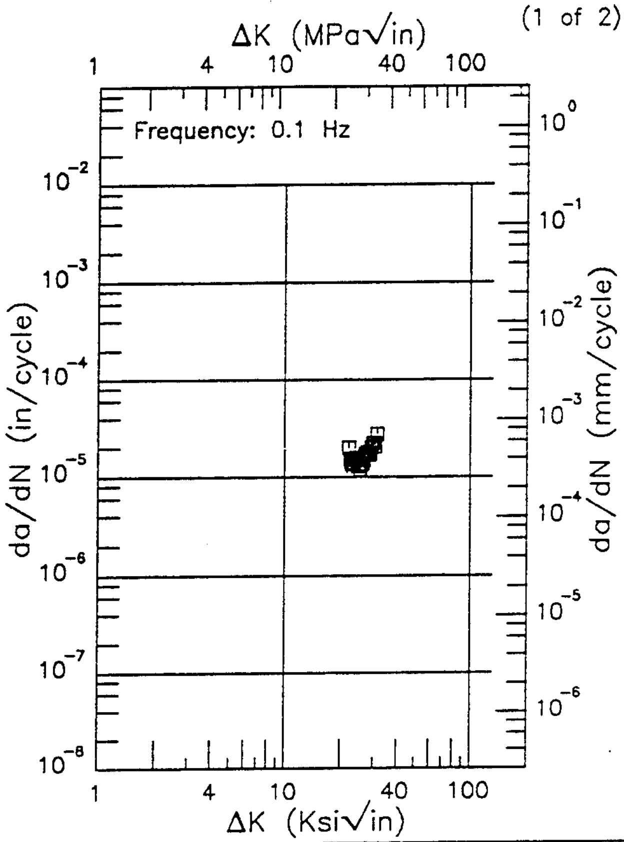
Figure 3.30.3.1.7 (Concluded)

F D6AC

Condition/Ht: 1650F A–BQ AT 975F SQ AT 400F 1000F 2+2HR
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.5
Environment: LAB AIR; RT

Yield Strength: 217 – 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.69 in.
Specimen Width: 1.5 in.
Ref: 82543

(1 of 2)



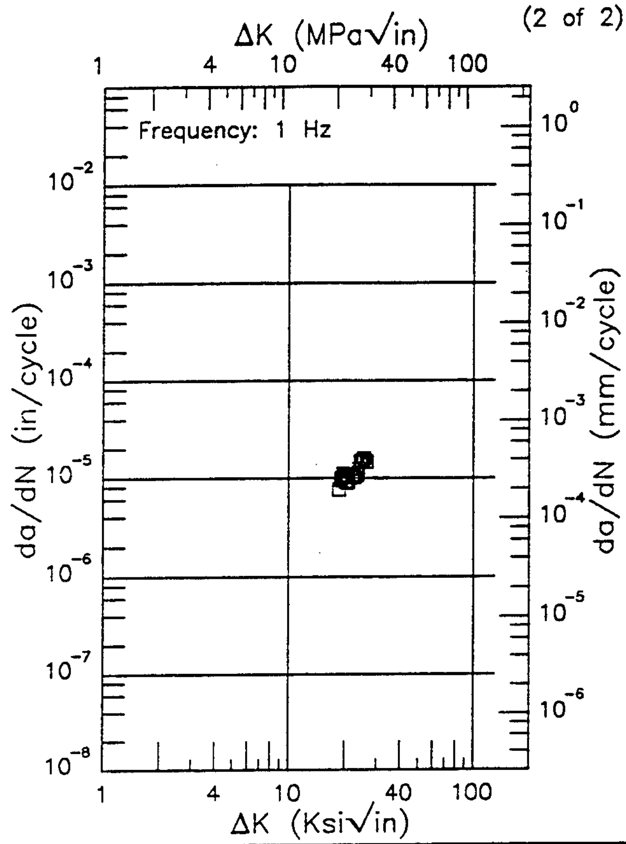
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
22.01 (min)	15.6
25.	14.0
30.	21.7
31.32 (max)	25.5

RMS % Error: 9.50

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.50 (min)	9.46
20.	9.29
25.	14.2
26.21 (max)	16.8

RMS % Error: 10.82

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.30.3.1.8

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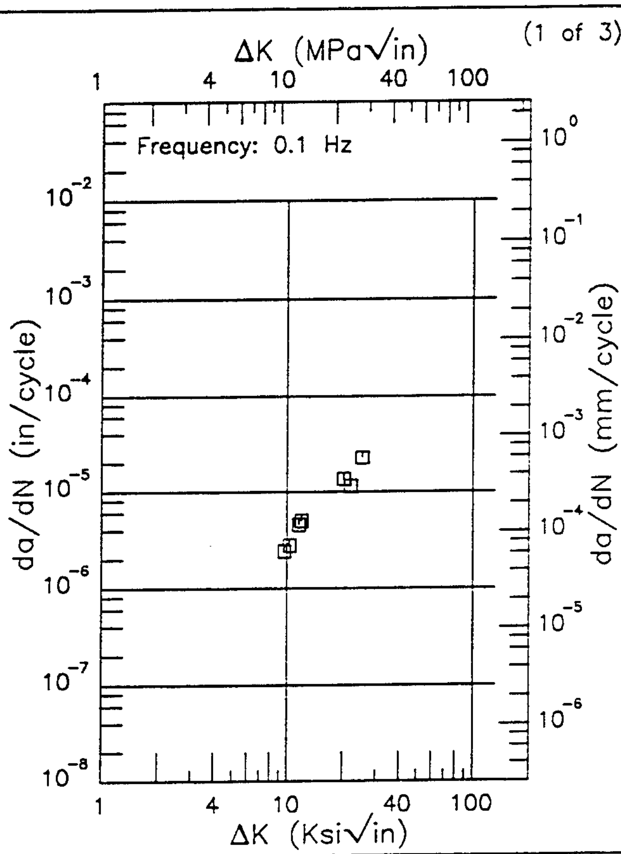
D6AC

F

Condition/Ht: 1650F A-BQ AT 975F SQ AT 400F 1000F 2+2HR
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.5
Environment: JP4; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.758 in.
Specimen Width: 5 in.
Ref: 82543

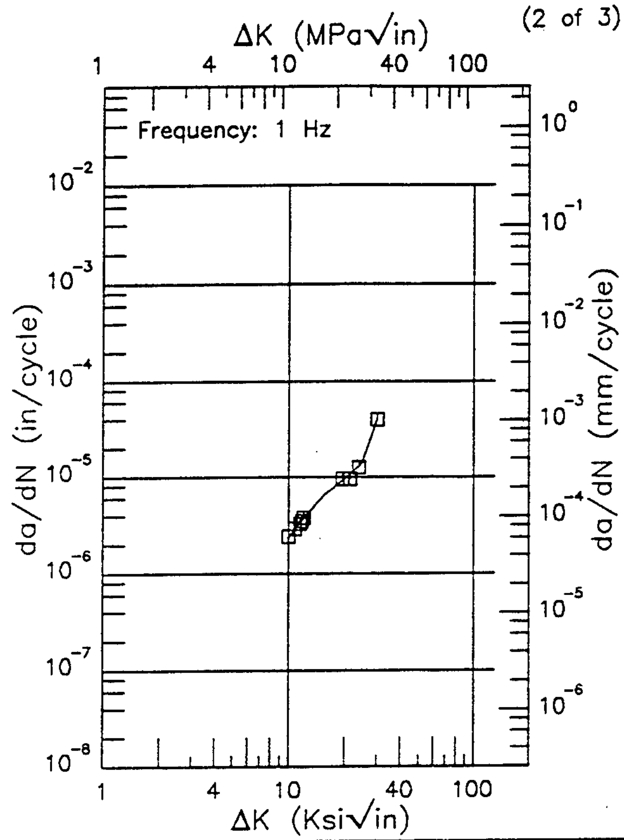
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

(2 of 3)



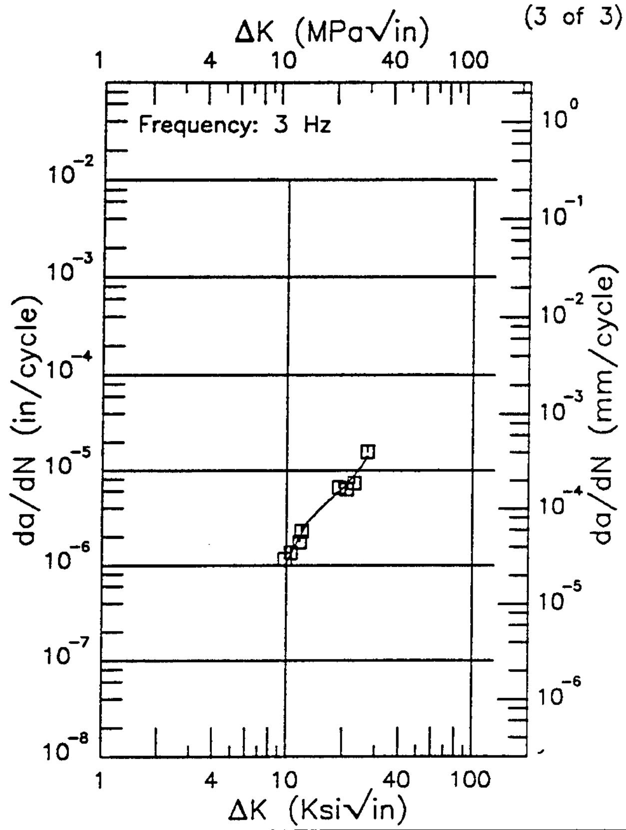
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.99 (min)	2.41
10.	2.41
13.	4.44
16.	6.86
20.	9.62
25.	13.9
29.90 (max)	39.3

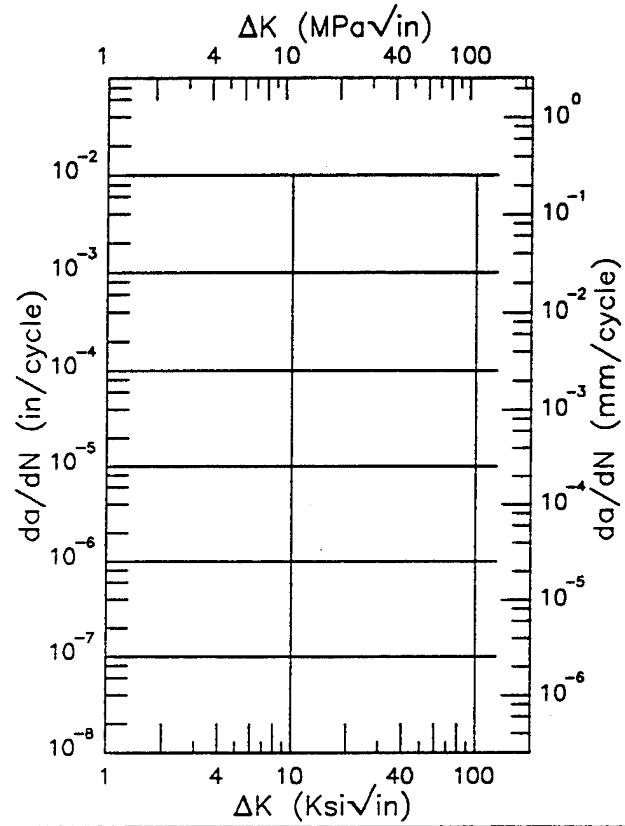
RMS % Error	Life Prediction Ratio Summary
4.01	0. .5 .8 1.25 2.

Figure 3.30.3.1.9

Condition/Ht: 1650F A–BQ AT 975F SQ AT 400F 1000F 2+2HR
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.5
Environment: JP4; RT
Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.758 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.80 (min)	0.980
10.	1.09
13.	2.83
16.	4.38
20.	6.45
25.	11.0
27.00 (max)	14.2

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
11.77	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

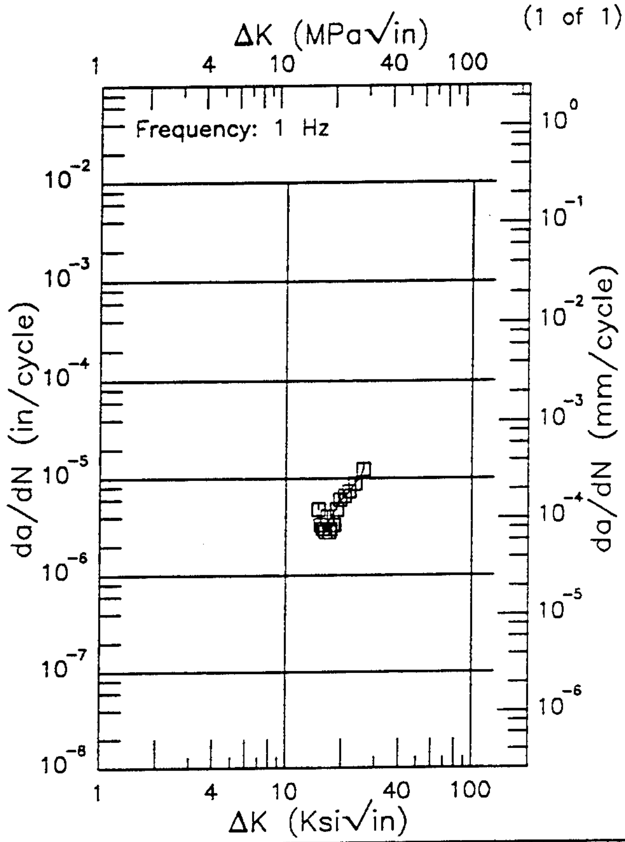
Figure 3.30.3.1.9 (Concluded)

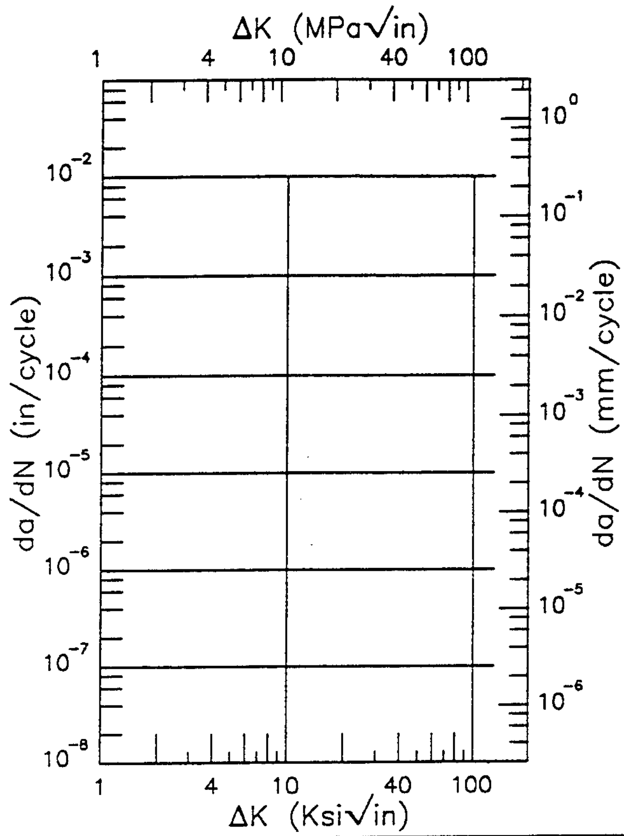
F D6AC

Condition/Ht: 1650F A–BQ AT 975F SQ AT 400F 1000F 2+2HR
Form: 0.8 in. Forging
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.5
Environment: JP4; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.5 in.
Specimen Width: 2.5 in.
Ref: 82543

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.94 (min)	4.28
16.	2.96
20.	6.00
25.	10.4
25.91 (max)	12.3

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
14.37	0. .5 .8 1.25 2.

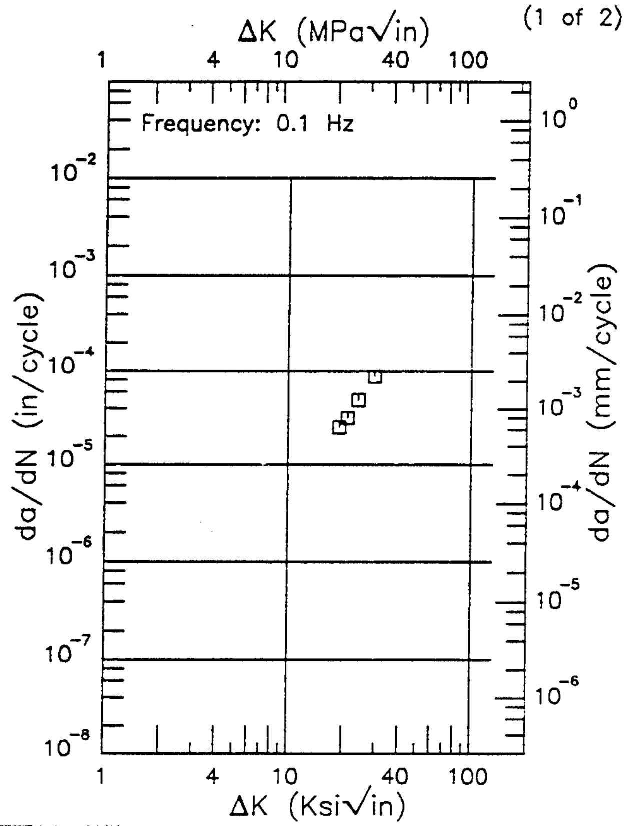
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.30.3.1.10

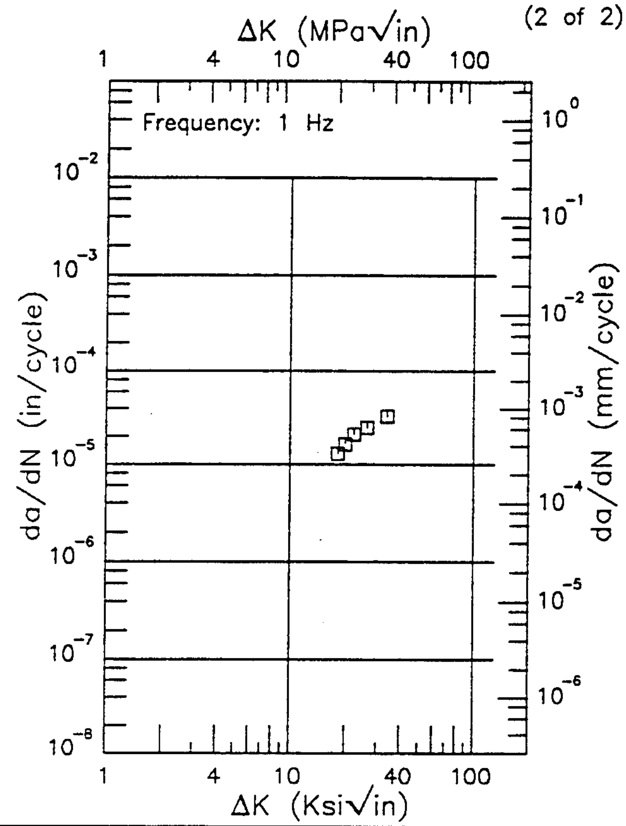
Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Environment: DIST WATER; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.754 in.
Specimen Width: 5 in.
Ref: 82543

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.30.3.1.11

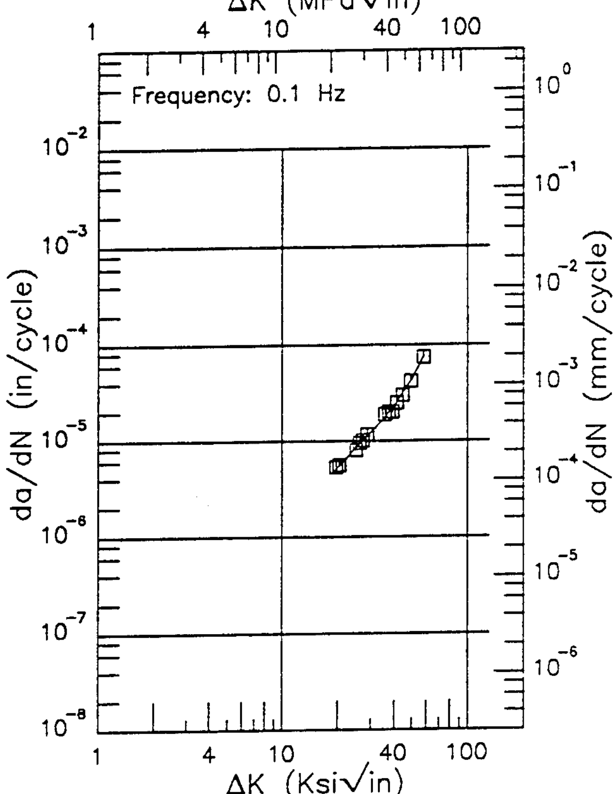
D6AC

F

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.1
Environment: DRY AIR; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.752 in.
Specimen Width: 5 in.
Ref: 82543

(1 of 3)



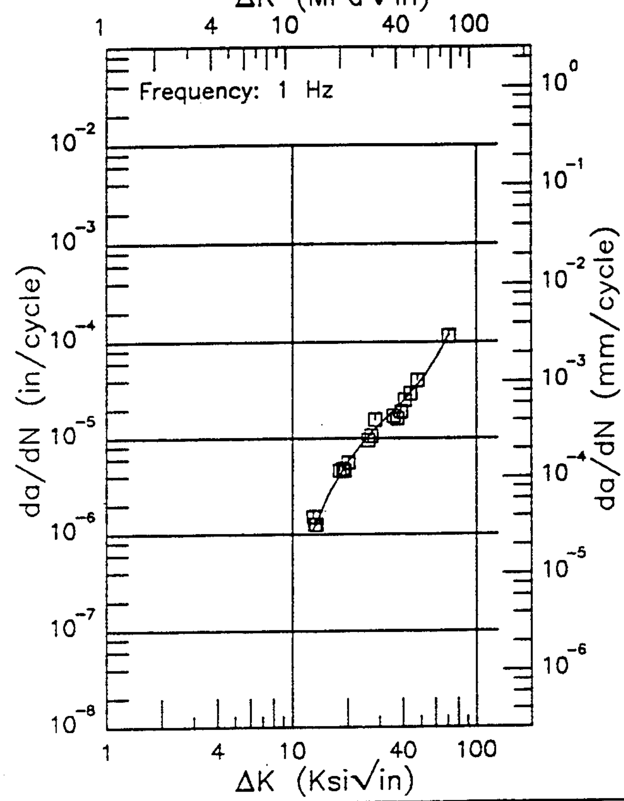
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.47 (min)	4.95
20.	5.28
25.	8.52
30.	12.3
35.	17.0
40.	23.2
50.	43.9
57.66 (max)	73.2

RMS % Error 4.51

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.94 (min)	1.10
13.	1.12
16.	2.75
20.	5.66
25.	9.77
30.	14.1
35.	18.9
40.	24.5
50.	40.2
60.	66.6
70.	114.
70.52 (max)	117.

RMS % Error 14.21

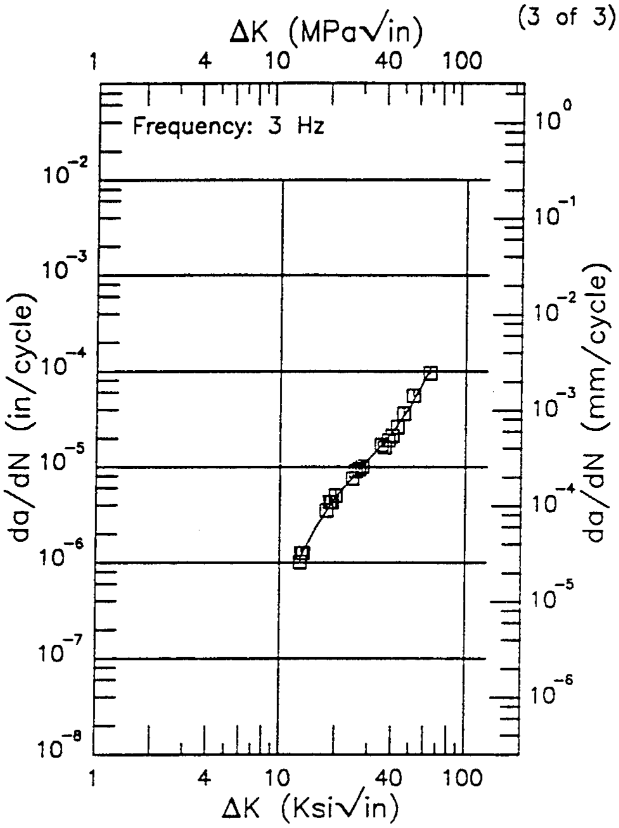
Life Prediction Ratio Summary

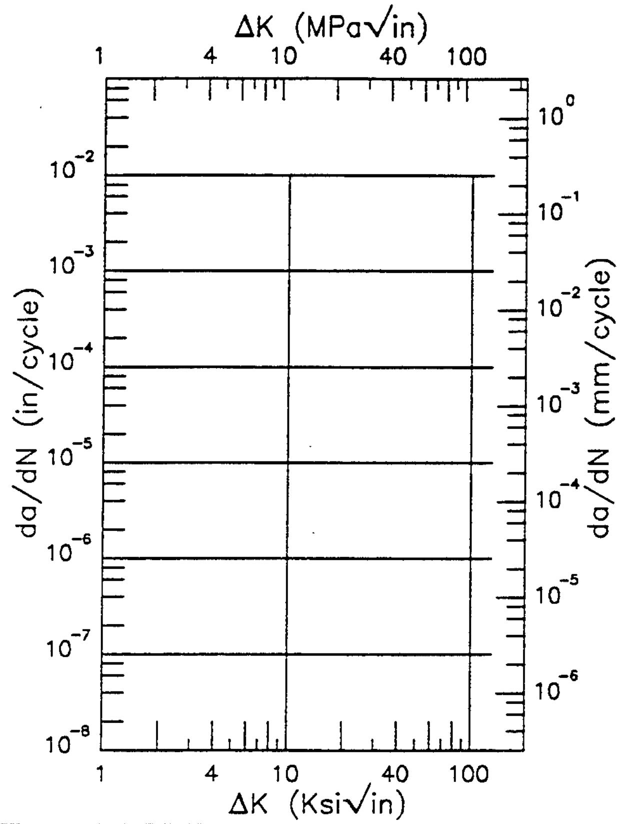
0. .5 .8 1.25 2.

Figure 3.30.3.1.12

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.1
Environment: DRY AIR; RT
Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.752 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
12.88 (min)	1.09
13.	1.14
16.	2.52
20.	4.86
25.	8.22
30.	12.1
35.	16.9
40.	23.2
50.	43.3
60.	83.0
63.32 (max)	104.

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
7.22	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.30.3.1.12 (Concluded)

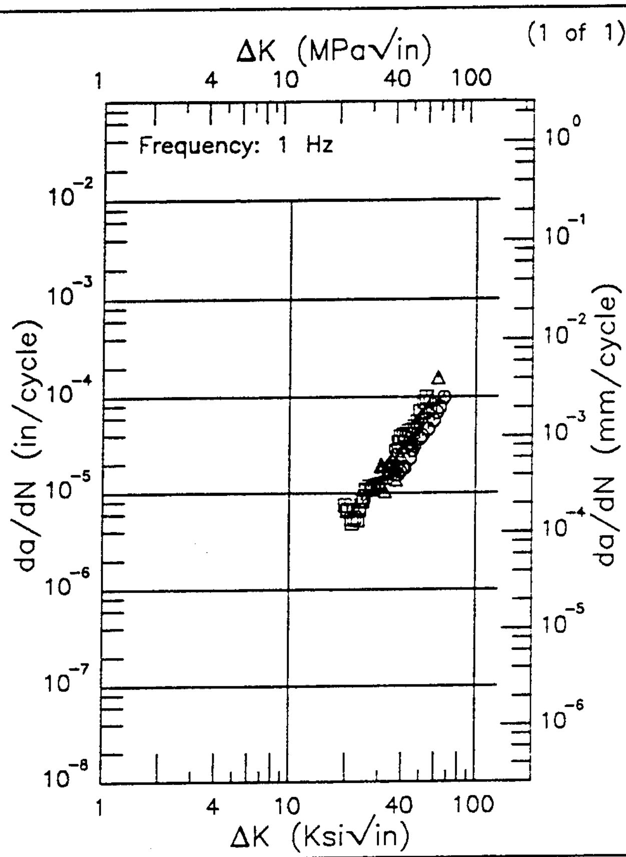
D6AC

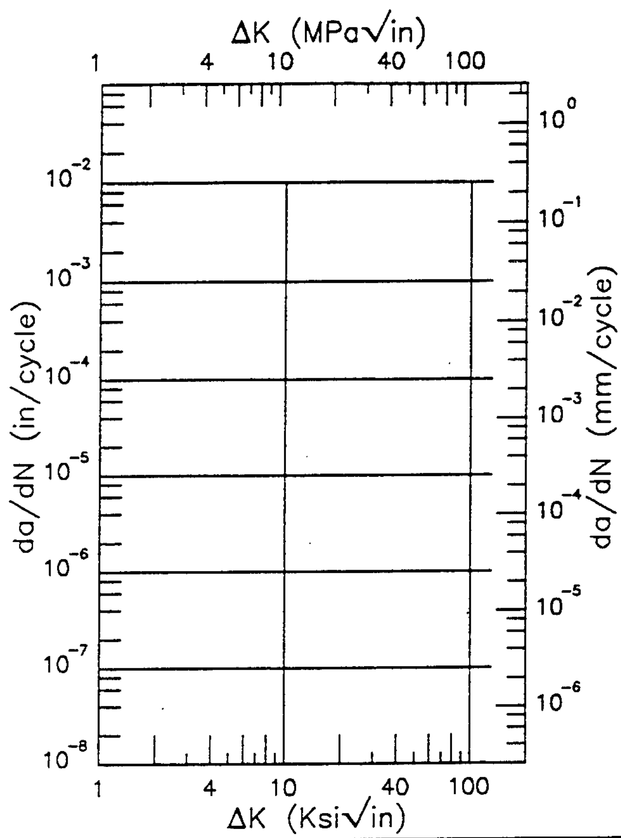
F

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Plate	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.69 in.
Stress Ratio: 0.1	Specimen Width: 1.5 in.
Environment: LAB AIR; RT	Ref: 82543

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.72 (min)	5.50
20.	5.61
25.	8.34
30.	12.8
35.	19.2
40.	27.7
50.	51.3
60.	81.9
66.91 (max)	105.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
25.80	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.30.3.1.13

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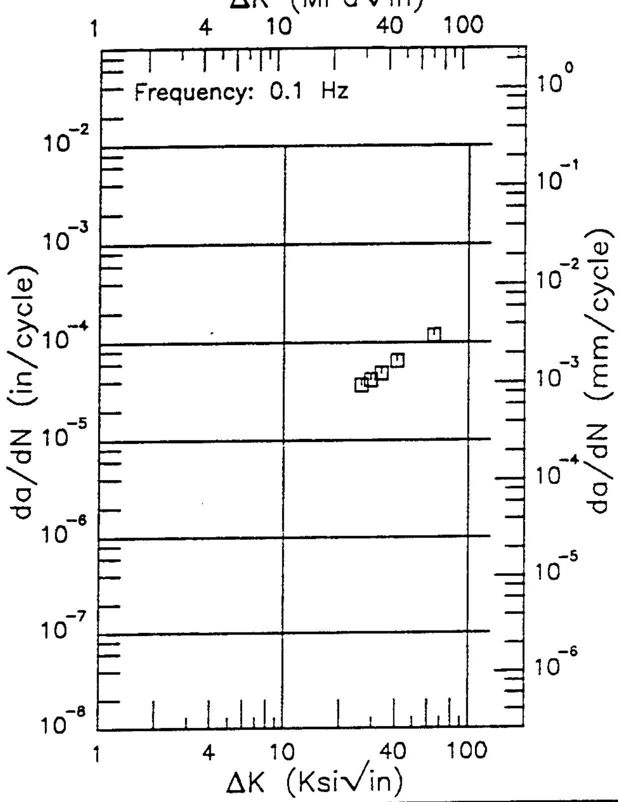
D6AC

F

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Plate	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.741 in.
Stress Ratio: 0.1	Specimen Width: 5 in.
Environment: JP4/H20; RT	Ref: 82543

(1 of 3)



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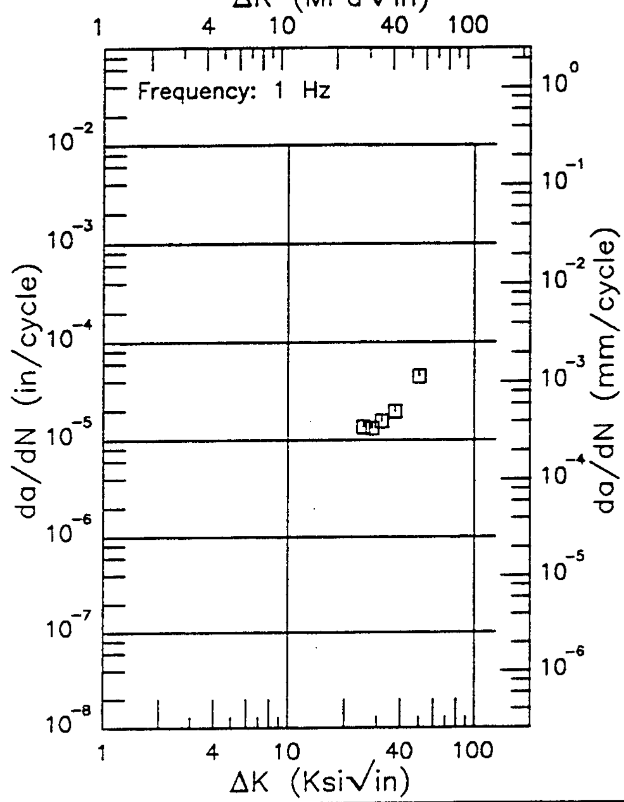


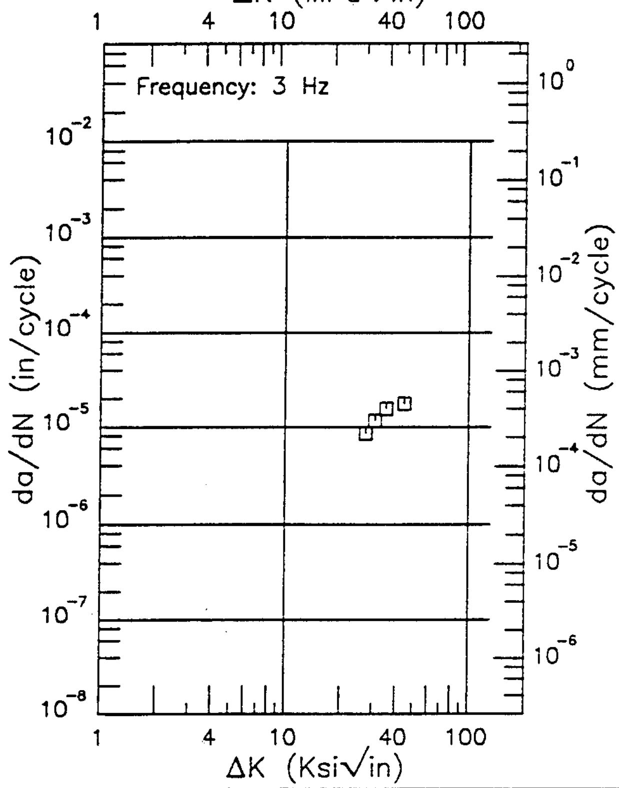
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

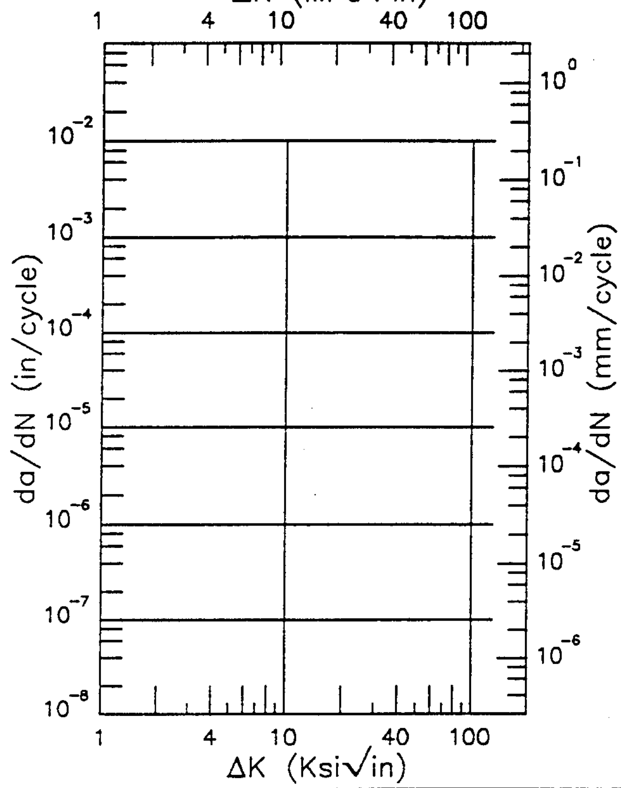
RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.30.3.1.14

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.1
Environment: JP4/H20; RT
Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.741 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.30.3.1.14 (Concluded)

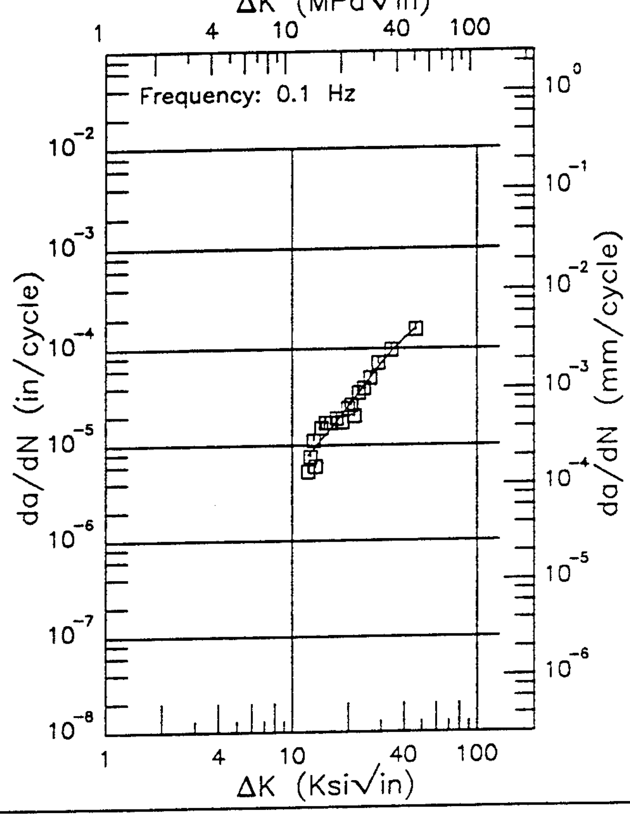
D6AC

F

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.11
Environment: DIST WATER; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.741 in.
Specimen Width: 5 in.
Ref: 82543

(1 of 3)



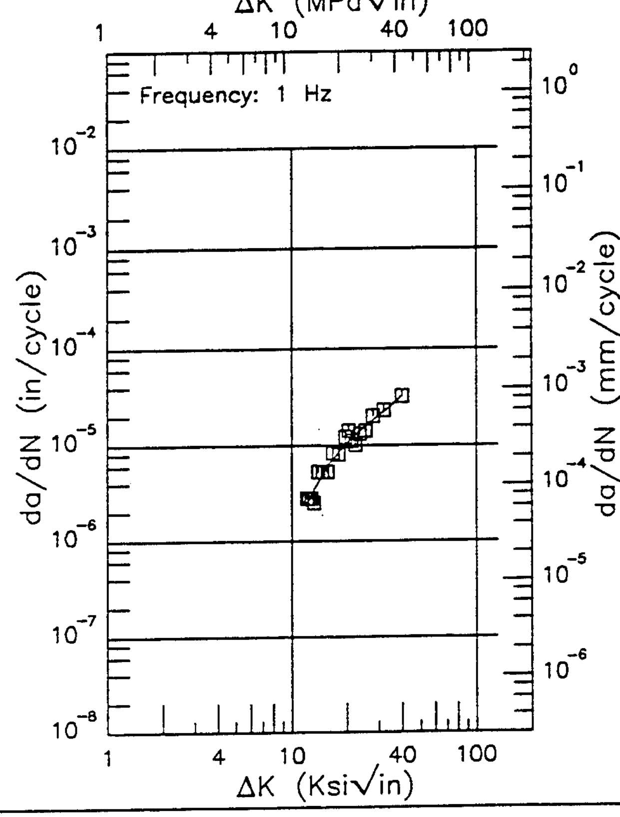
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.13 (min)	7.97
13.	9.15
16.	14.6
20.	25.4
25.	44.9
30.	69.9
35.	98.1
40.	127.
46.20 (max)	158.

RMS % Error 20.48

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.01 (min)	2.35
13.	3.25
16.	6.39
20.	10.7
25.	15.6
30.	20.5
35.	26.1
39.73 (max)	32.9

RMS % Error 15.65

Life Prediction Ratio Summary

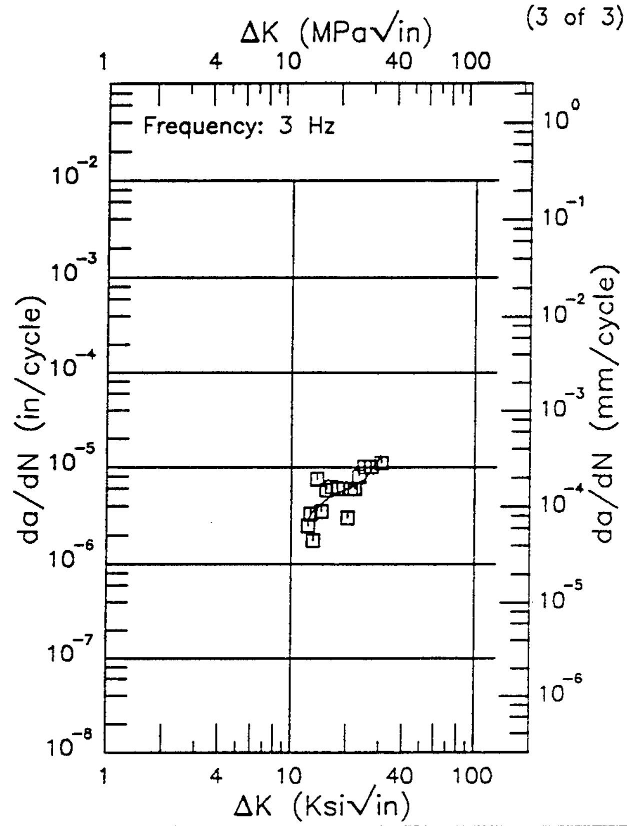
0. .5 .8 1.25 2.

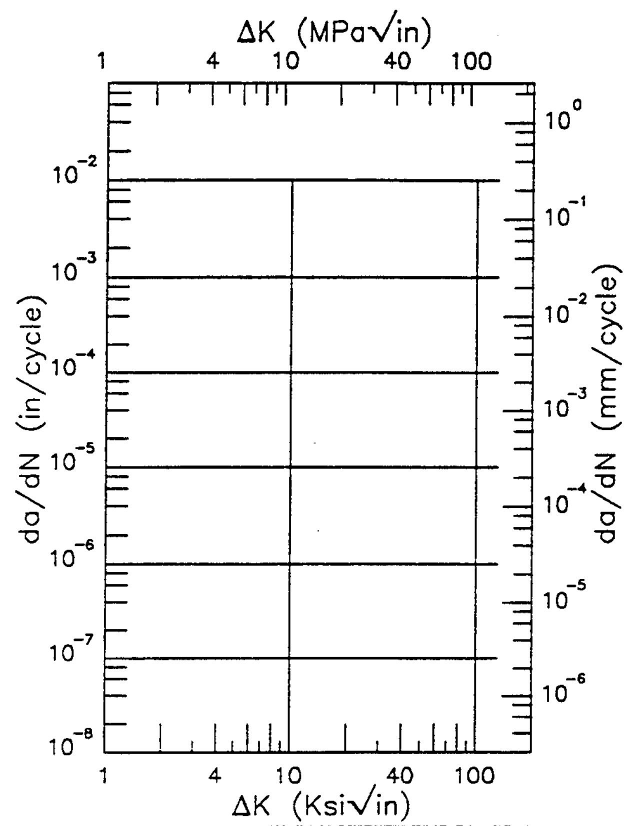
Figure 3.30.3.1.15

Condition/Ht: 1700F A–BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.11
Environment: DIST WATER; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.741 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.24 (min)	2.81
13.	3.40
16.	4.97
20.	5.88
25.	7.59
30.	12.6
30.48 (max)	13.5

ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

RMS % Error 35.22

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.30.3.1.15 (Concluded)

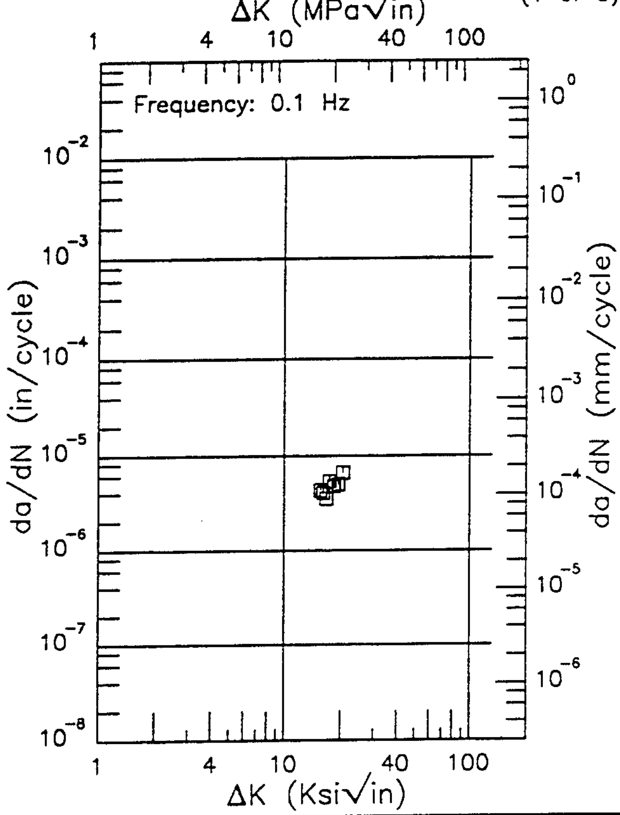
F

D6AC

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Plate	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.751 in.
Stress Ratio: 0.5	Specimen Width: 5 in.
Environment: DRY AIR; RT	Ref: 82543

(1 of 3)



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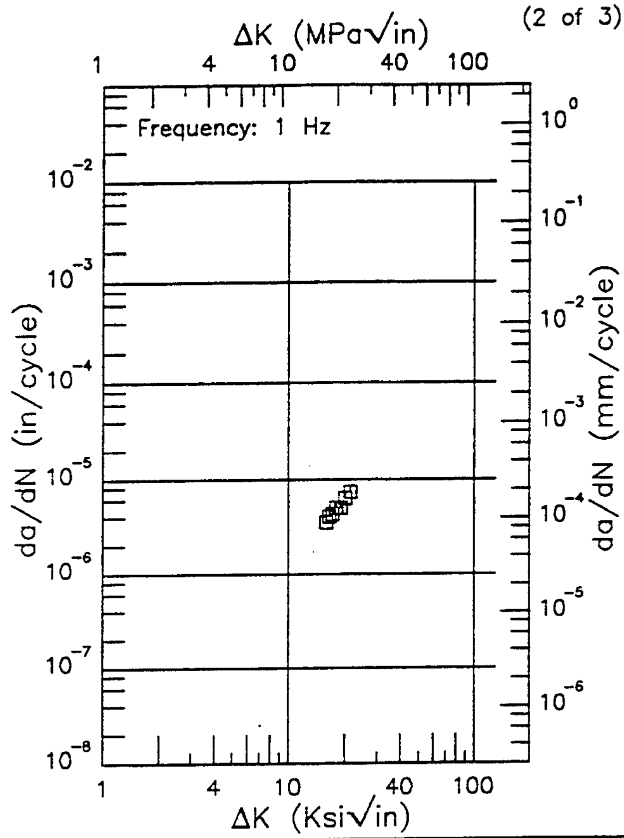


ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

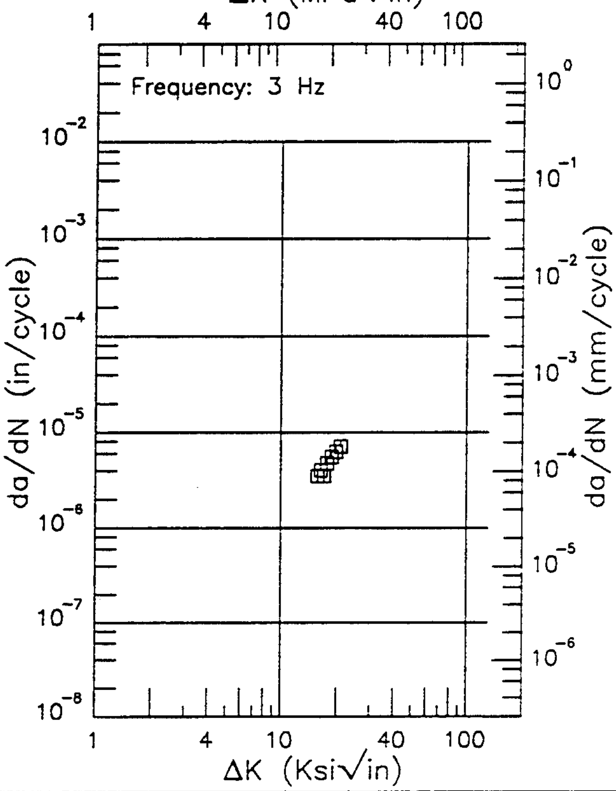
RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

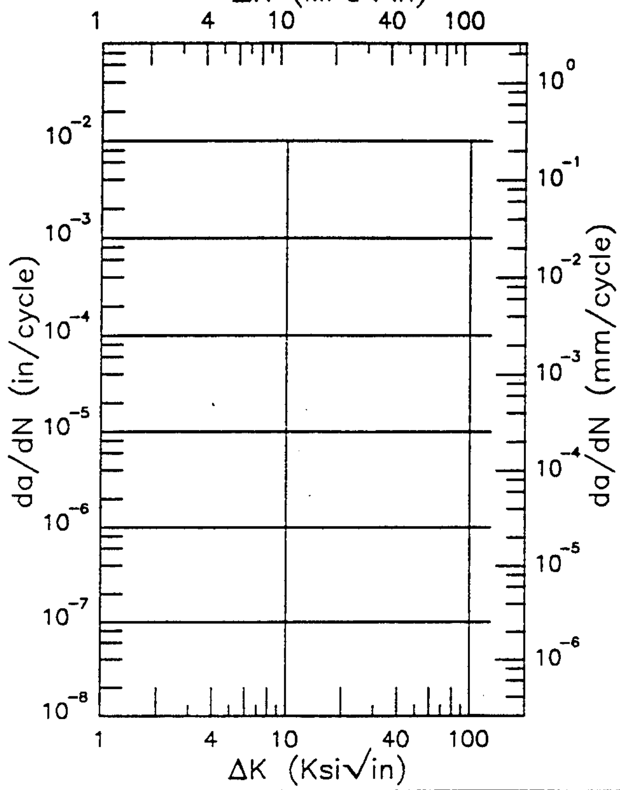
Figure 3.30.3.1.16

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.5
Environment: DRY AIR; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.751 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 3.30.3.1.16 (Concluded)

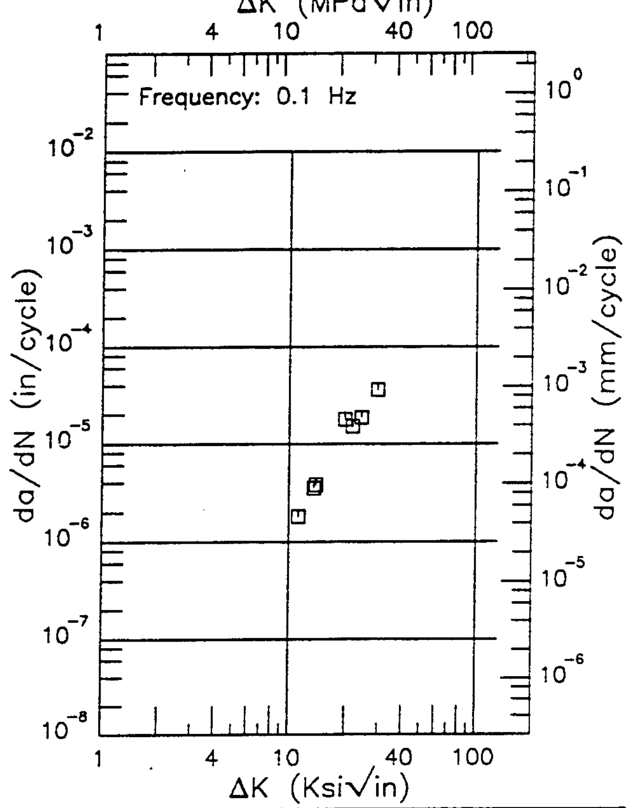
F — D6AC

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.5
Environment: JP4; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.75 in.
Specimen Width: 5 in.
Ref: 82543

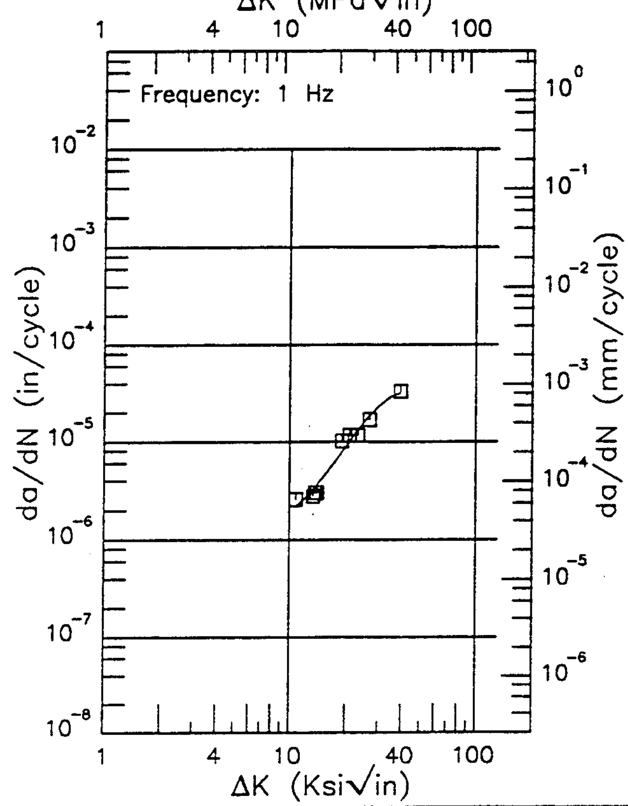
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
10.80 (min)	2.19
13.	3.02
16.	4.92
20.	8.95
25.	15.9
30.	23.4
35.	29.2
39.01 (max)	31.7

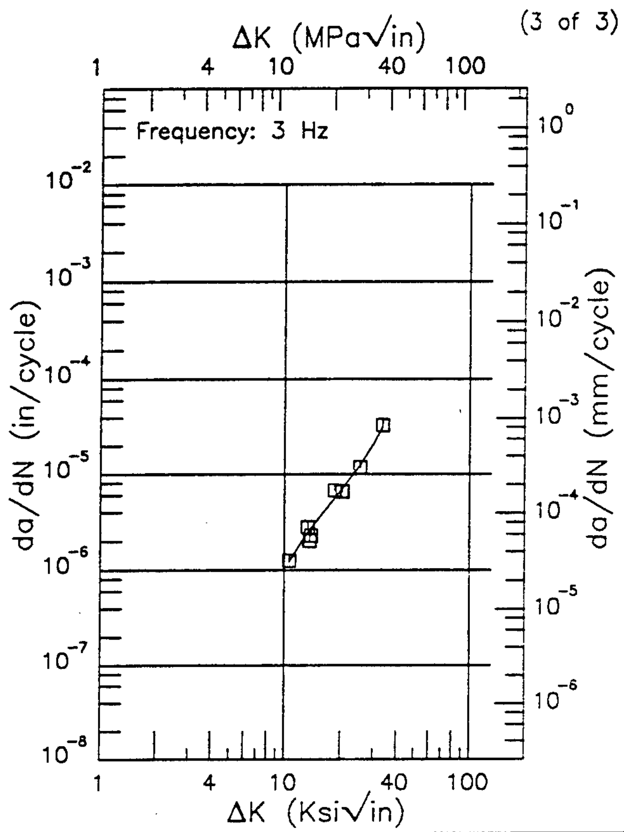
RMS % Error	Life Prediction Ratio Summary
15.41	0. .5 .8 1.25 2.

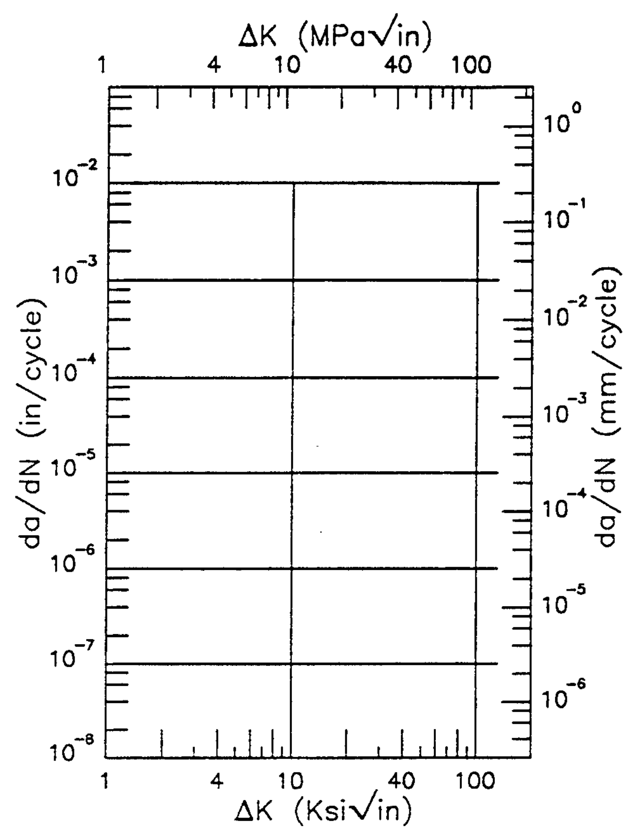
Figure 3.30.3.1.17

Condition/Ht: 1700F A–BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Plate
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.5
Environment: JP4; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.75 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.58 (min)	1.20
13.	2.29
16.	3.93
20.	6.73
25.	12.0
30.	21.0
33.66 (max)	31.9

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
13.57	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

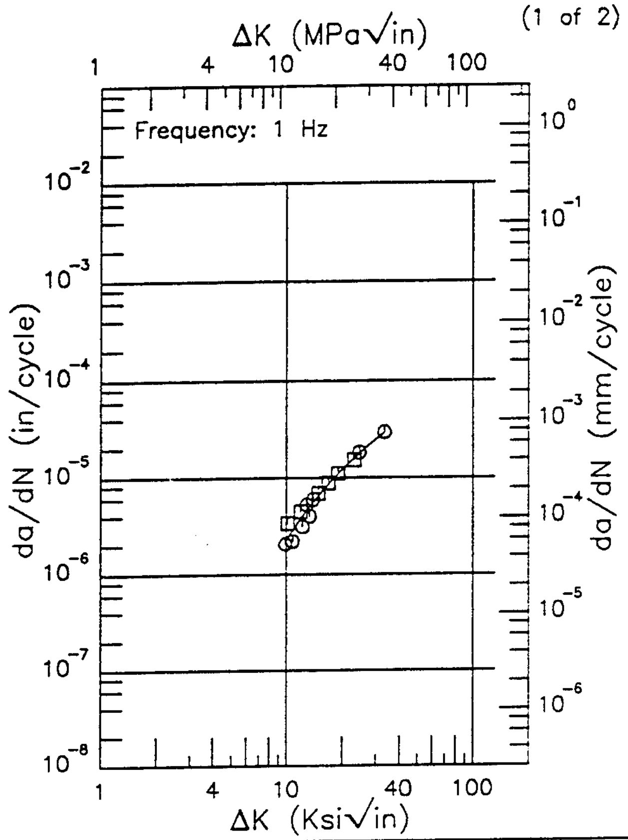
Figure 3.30.3.1.17 (Concluded)

D6AC

F

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS	
Form: 0.8 in. Plate	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.751 in.
Stress Ratio: 0.5	Specimen Width: 5 in.
Environment: DIST WATER; RT	Ref: 82543

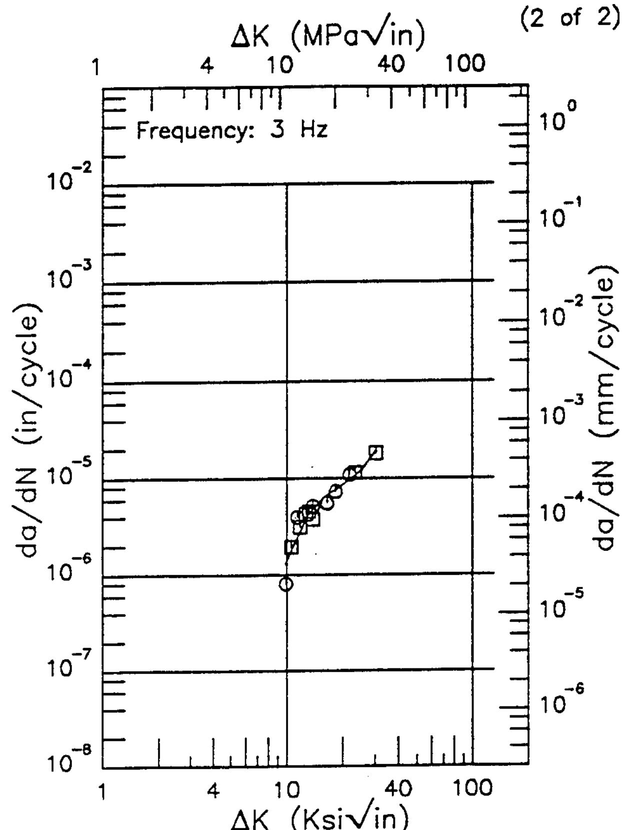
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.81 (min)	2.20
10.	2.33
13.	4.71
16.	7.69
20.	12.2
25.	18.4
30.	24.9
33.23 (max)	29.1

RMS % Error	Life Prediction Ratio Summary
16.56	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.86 (min)	1.32
10.	1.43
13.	4.18
16.	6.44
20.	8.56
25.	11.8
30.	18.6
30.17 (max)	18.9

RMS % Error	Life Prediction Ratio Summary
23.42	0. .5 .8 1.25 2.

Figure 3.30.3.1.18

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F

D6AC

Condition/Ht: 1700F A–BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Forging

Specimen Type: CT

Orientation: L–T

Stress Ratio: 0.1

Environment: JP4; RT

Yield Strength: 220 ksi

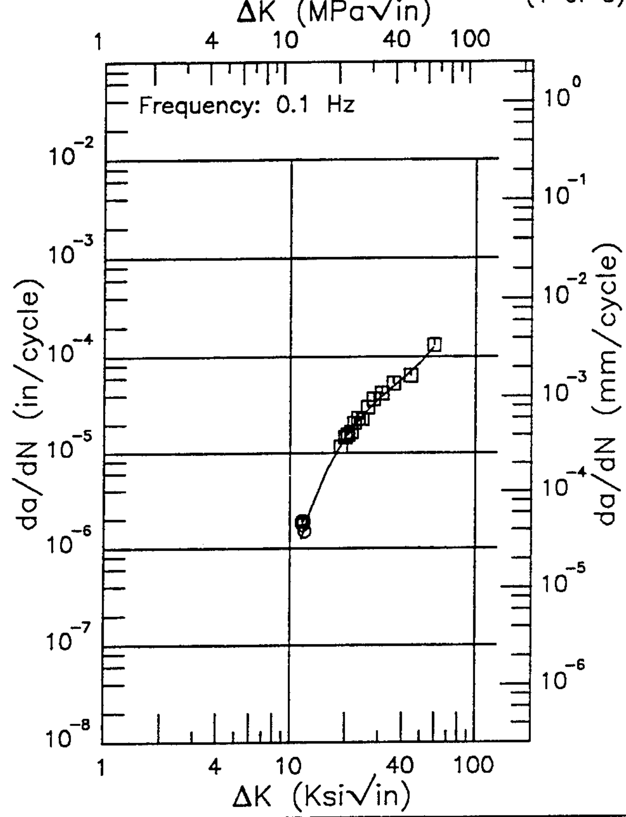
Ult. Strength: 238 ksi

Specimen Thk: 0.75 – 0.753 in.

Specimen Width: 5 in.

Ref: 82543

(1 of 3)



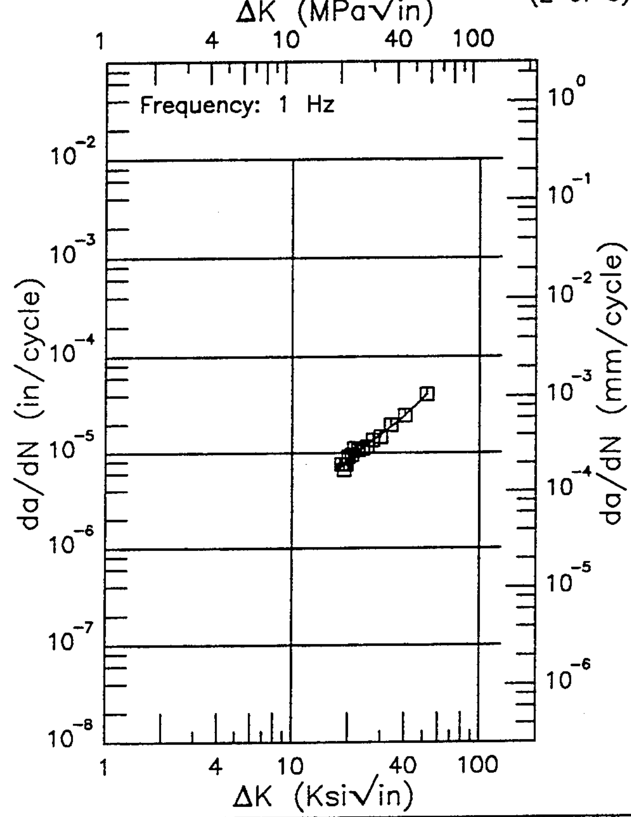
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.55 (min)	1.25
13.	2.52
16.	6.78
20.	14.8
25.	26.1
30.	37.2
35.	48.2
40.	59.7
50.	87.6
58.94 (max)	123.

RMS % Error: 18.78

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.43 (min)	7.19
20.	8.37
25.	12.0
30.	15.7
35.	19.8
40.	24.5
50.	37.4
52.16 (max)	41.1

RMS % Error: 6.99

Life Prediction Ratio Summary

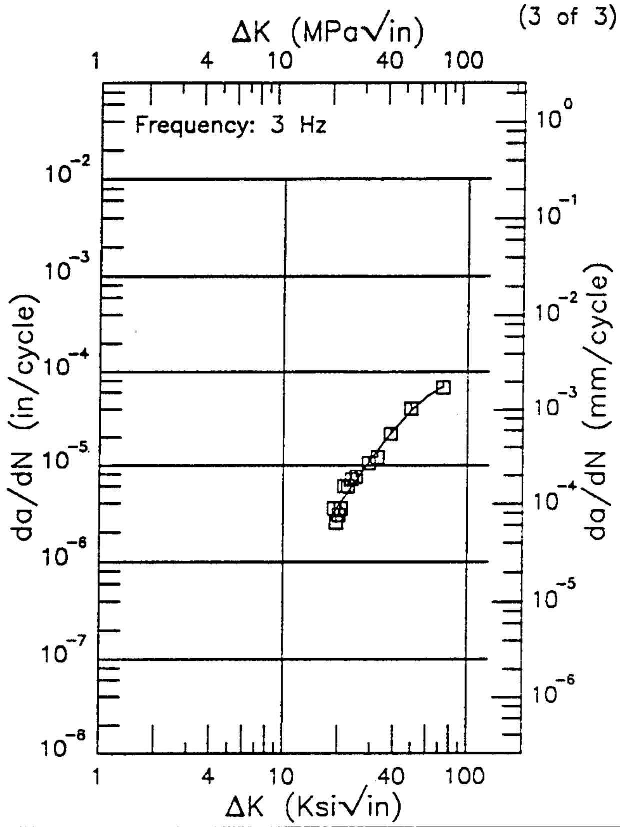
0. .5 .8 1.25 2.

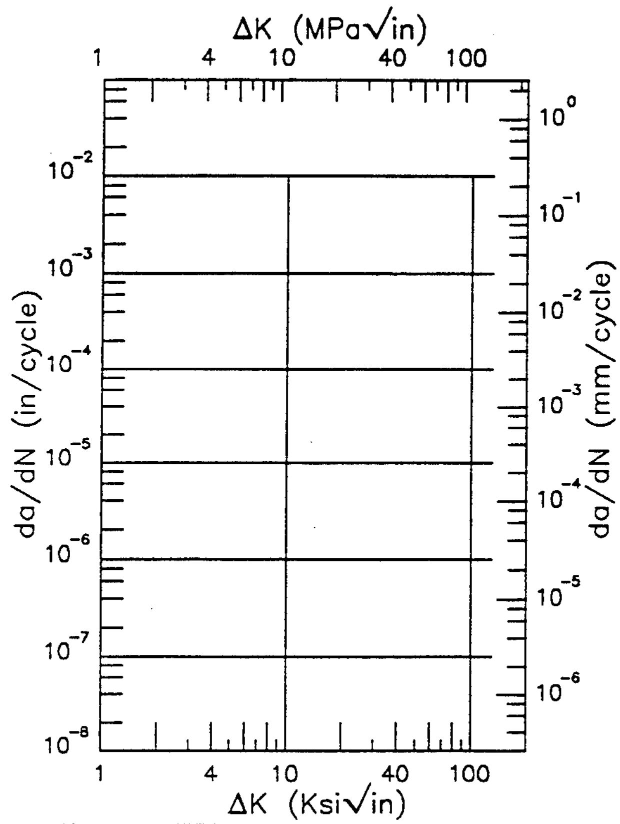
Figure 3.30.3.1.19

Condition/Ht: 1700F A–BQ AT 975F OQ AT 140F 1000F 2+2HRS
Form: 0.8 in. Forging
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.1
Environment: JP4; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.75 – 0.753 in.
Specimen Width: 5 in.
Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.87 (min)	3.18
20.	3.73
25.	6.93
30.	11.5
35.	17.3
40.	24.1
50.	39.4
60.	54.4
70.	66.4
72.93 (max)	69.1

ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
16.35	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.30.3.1.19 (Concluded)

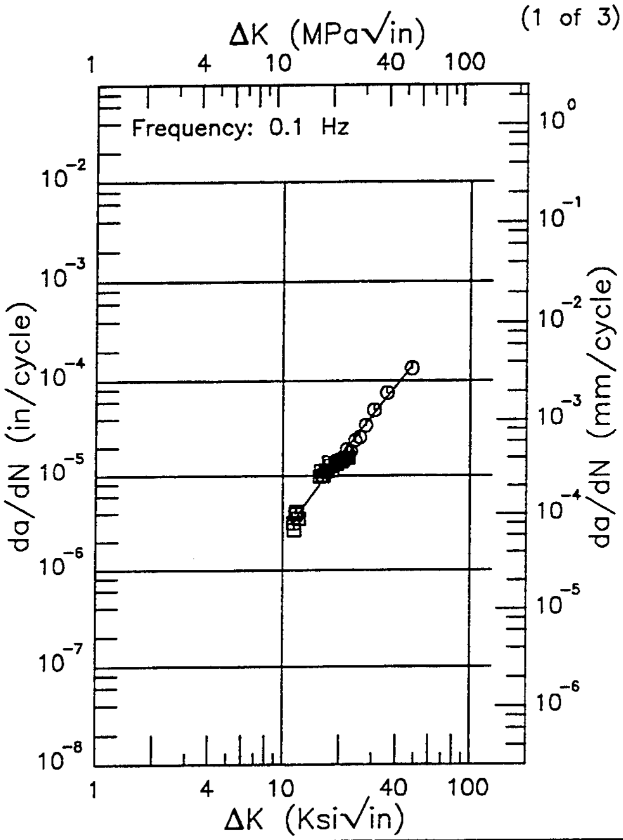
F — D6AC

Condition/Ht: 1700F A–BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Forging
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.1
Environment: DIST WATER; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.75 – 0.753 in.
Specimen Width: 5 in.
Ref: 82543

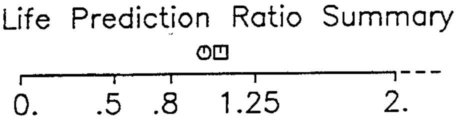
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.33 (min)	3.18
13.	4.80
16.	8.65
20.	15.7
25.	27.8
30.	43.7
35.	63.7
40.	88.2
48.33 (max)	140.

RMS % Error: 13.48

Life Prediction Ratio Summary



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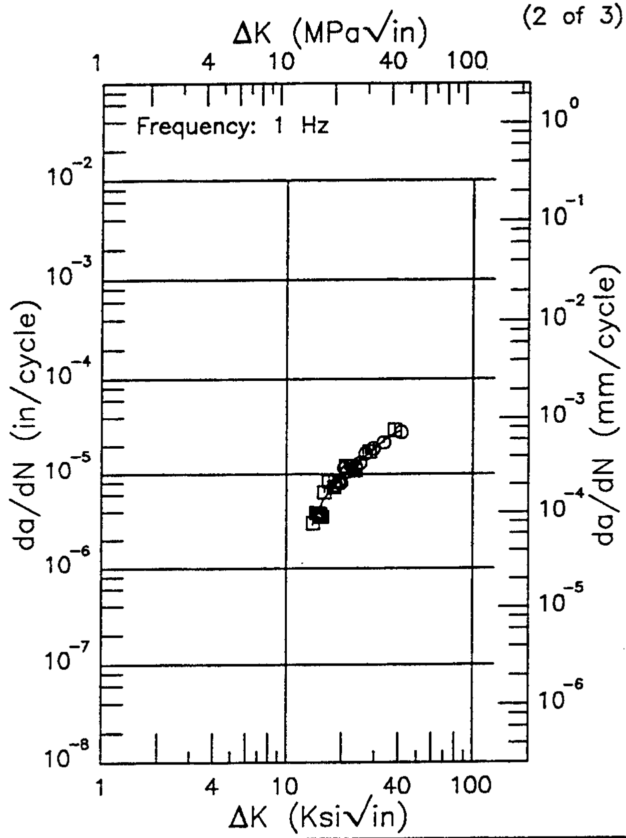


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.93 (min)	2.89
16.	5.32
20.	9.61
25.	13.8
30.	18.8
35.	24.9
40.	28.6
41.12 (max)	28.8

RMS % Error: 11.47

Life Prediction Ratio Summary

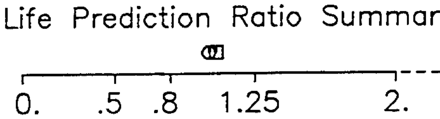
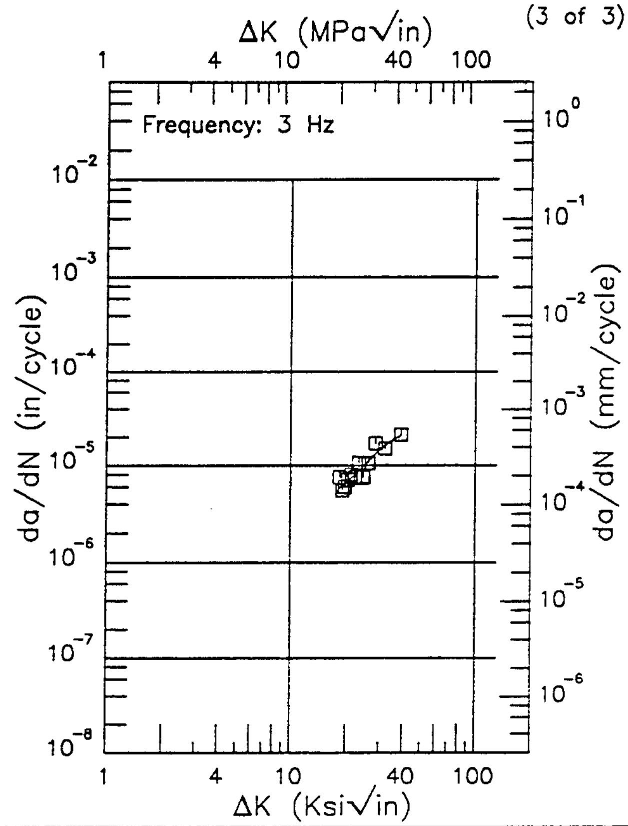


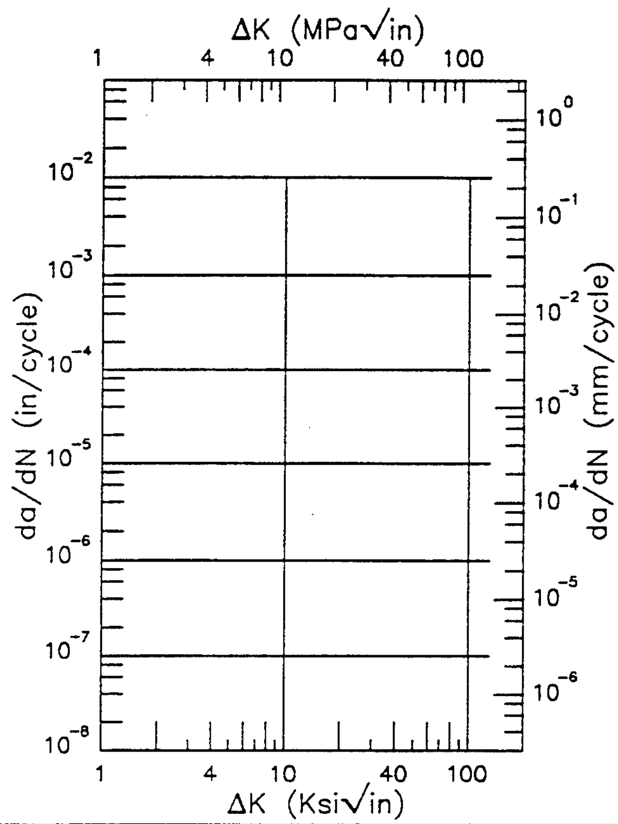
Figure 3.30.3.1.20

Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Forging	Yield Strength: 220 ksi
Specimen Type: CT	Ult. Strength: 238 ksi
Orientation: L-T	Specimen Thk: 0.75 - 0.753 in.
Stress Ratio: 0.1	Specimen Width: 5 in.
Environment: DIST WATER; RT	Ref: 82543

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
18.38 (min)	5.90
20.	6.68
25.	10.2
30.	14.7
35.	18.7
38.83 (max)	20.5

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error 15.42

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.30.3.1.20 (Concluded)

F

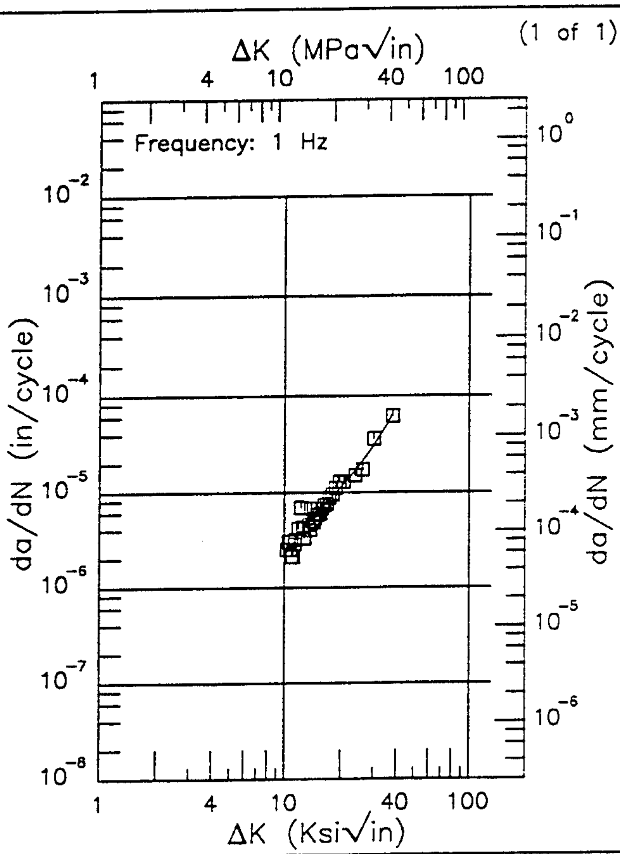
D6AC

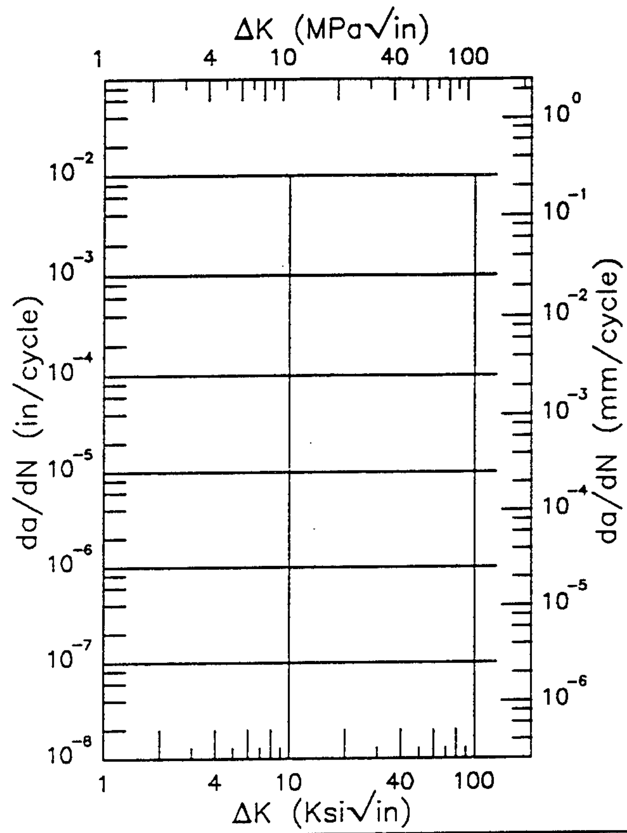
Condition/Ht: 1700F A-BQ AT 975F OQ AT 140F 1000F 2+2HRS

Form: 0.8 in. Forging
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.48
Environment: DIST WATER; RT

Yield Strength: 220 ksi
Ult. Strength: 238 ksi
Specimen Thk: 0.75 in.
Specimen Width: 5 in.
Ref: 82543

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.29 (min)	2.39
13.	4.44
16.	7.10
20.	11.4
25.	19.0
30.	30.5
35.	48.8
37.89 (max)	64.3

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
19.65	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.30.3.1.21

TABLE 3.30.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL D6AC

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1550°F 25min OQ; 850°F 1+1 hr	S	R.T.	L-T	224.7	3N NaCl	CNT	2	0.05	0.08	---	---	33⁺	---	1968	72283
					Dist. Water	CNT	2	0.05	0.08	---	---	33⁺	---	1968	72283
1550°F AQ; 650°F 4hr	S	R.T.	L-T	241.5	Dist. Water	CANT*	0.75	0.165	0.16	0.1	61.7	7	---	1965	63061
1550°F AQ; 950°F 4hr	S	R.T.	L-T	217.3	Dist. Water	CANT*	0.75	0.165	0.16	0.1	95.7	45.2	10000	1965	63061

⁺ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.31.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK H11 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
AUSTENIZED & TEMPERED (TYS=220KSI)	ROUND BAR	0.1	10				3.53		
		0.1	30			0.34	2.95		
		0.5	10				4.94		
		0.5	30		0.09	0.72	4.93		

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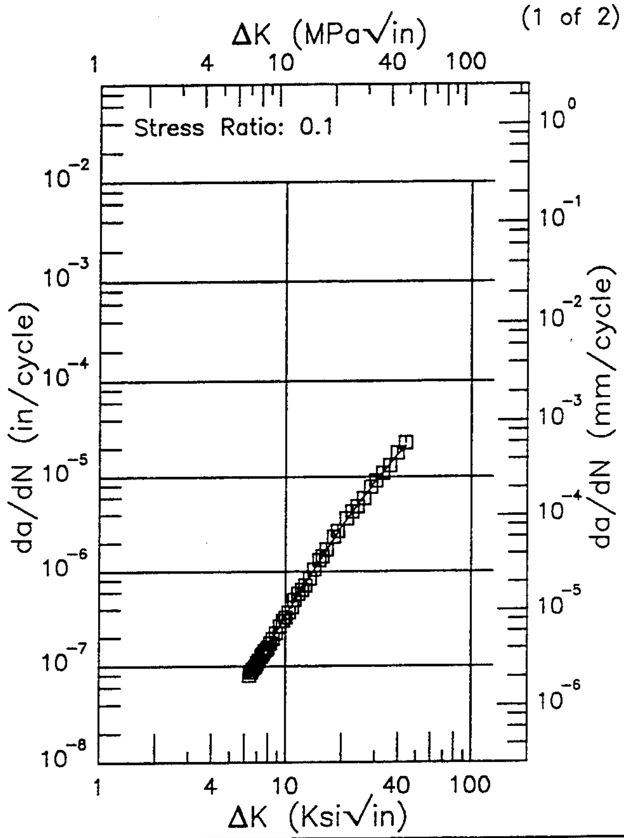
R

H11

Condition/Ht: AUSTENIZED & TEMPERED (TYS=220KSI)
Form: 3.18 in. Round Bar
Specimen Type: CT
Orientation: L-T
Frequency: 30 Hz
Environment: LAB AIR; RT

Yield Strength: 215.4 ksi
Ult. Strength: 258.1 ksi
Specimen Thk: 0.256 - 0.257 in.
Specimen Width: 2.002 in.
Ref: DA001

(1 of 2)

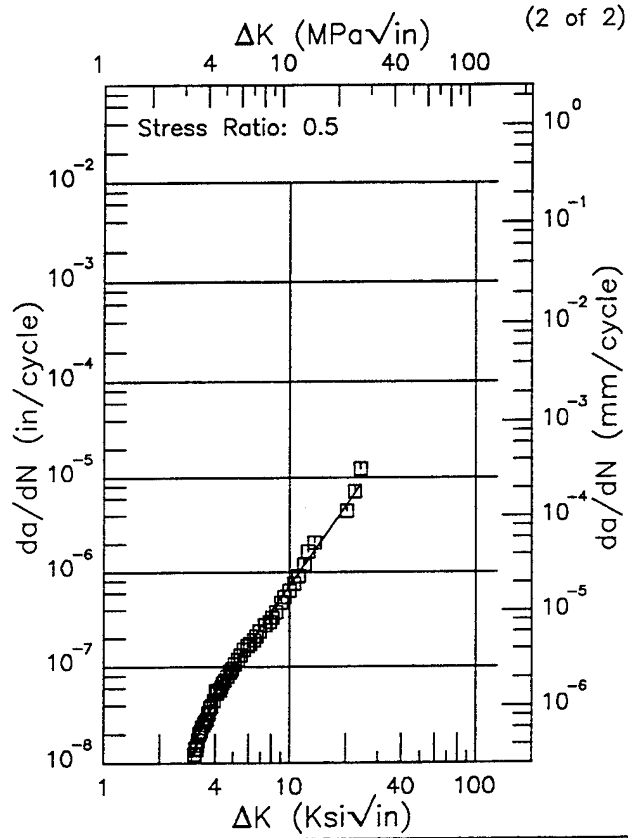


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.34 (min)	0.0758
7.	0.105
8.	0.163
9.	0.240
10.	0.339
13.	0.791
16.	1.51
20.	2.95
25.	5.52
30.	8.88
35.	12.9
40.	17.4
44.01 (max)	21.3

RMS % Error: 3.81

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.07 (min)	0.0162
3.5	0.0267
4.	0.0434
5.	0.0924
6.	0.164
7.	0.261
8.	0.385
9.	0.537
10.	0.721
13.	1.48
16.	2.63
20.	4.93
23.97 (max)	8.38

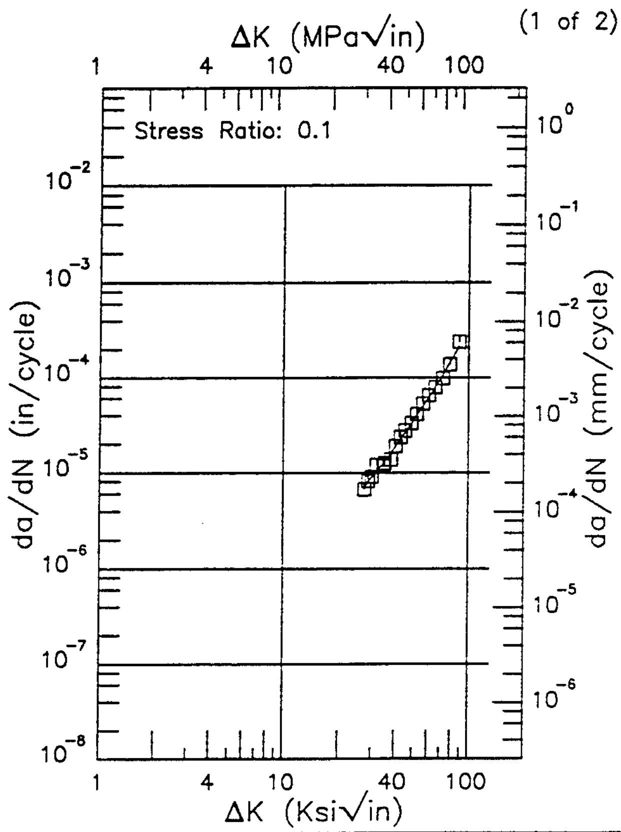
RMS % Error: 14.13

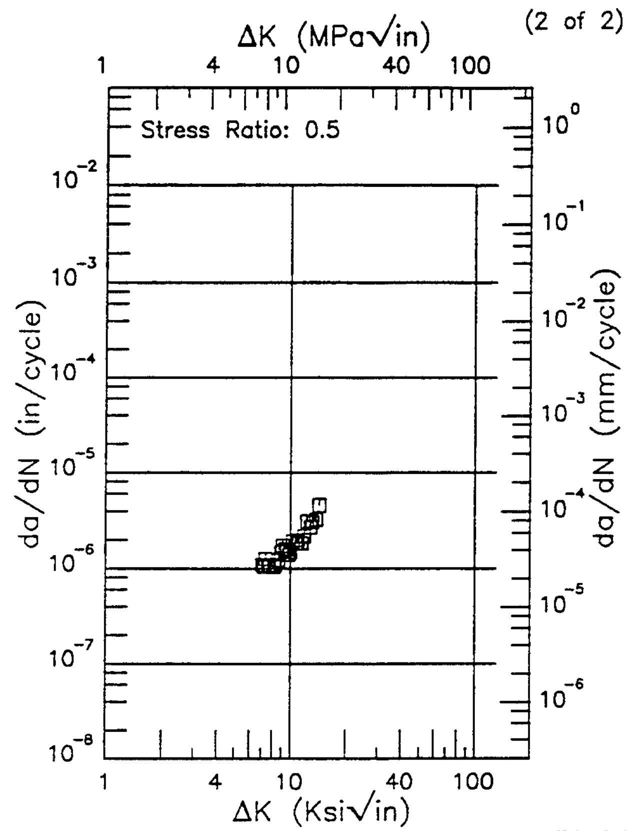
Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 3.31.3.1.1

Condition/Ht: AUSTENIZED & TEMPERED (TYS=220KSI)
Form: 3.18 in. Round Bar
Specimen Type: CT
Orientation: L–T
Frequency: 7 Hz
Environment: LAB AIR;650°F

Yield Strength: 215.4 ksi
Ult. Strength: 258.1 ksi
Specimen Thk: 0.257 – 0.488 in.
Specimen Width: 2 in.
Ref: DA001





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
27.33 (min)	7.00
30.	8.83
35.	13.1
40.	18.6
50.	34.6
60.	59.8
70.	97.9
80.	154.
87.90 (max)	216.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.01 (min)	1.03
8.	1.17
9.	1.36
10.	1.61
13.	2.95
14.30 (max)	3.96

RMS % Error 6.97

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error 11.25

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.31.3.1.2

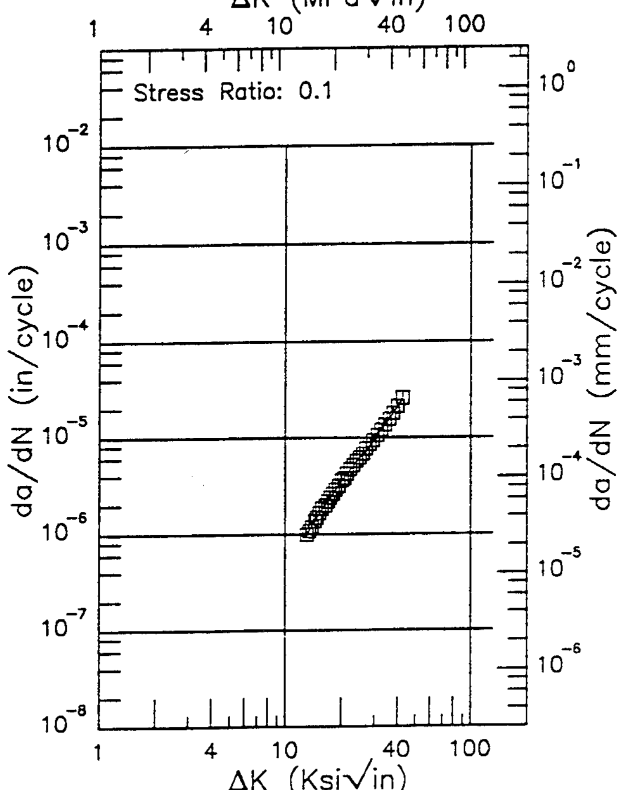
H11

R

Condition/Ht: AUSTENIZED & TEMPERED (TYS=220KSI)
Form: 3.18 in. Round Bar
Specimen Type: CT
Orientation: L-T
Frequency: 10 Hz
Environment: LAB AIR; RT

Yield Strength: 215.4 ksi
Ult. Strength: 258.1 ksi
Specimen Thk: 0.488 in.
Specimen Width: 2.005 – 2.01 in.
Ref: DA001

(1 of 2)



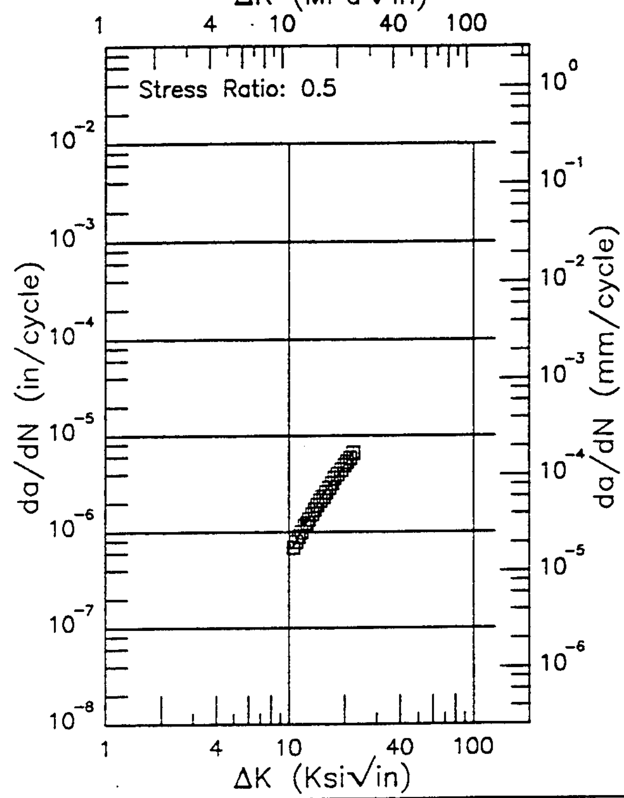
ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
12.92 (min)	0.949
13.	0.970
16.	1.90
20.	3.53
25.	6.19
30.	9.73
35.	14.5
40.	20.9
42.50 (max)	24.9

RMS % Error 1.25

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
10.54 (min)	0.691
13.	1.41
16.	2.66
20.	4.94
22.18 (max)	6.46

RMS % Error 1.62

Life Prediction Ratio Summary

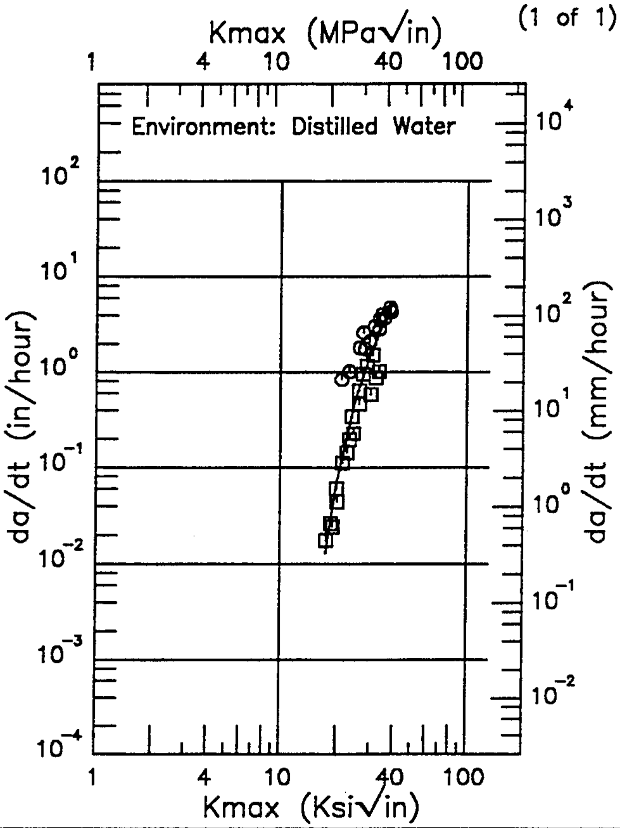
0. .5 .8 1.25 2.

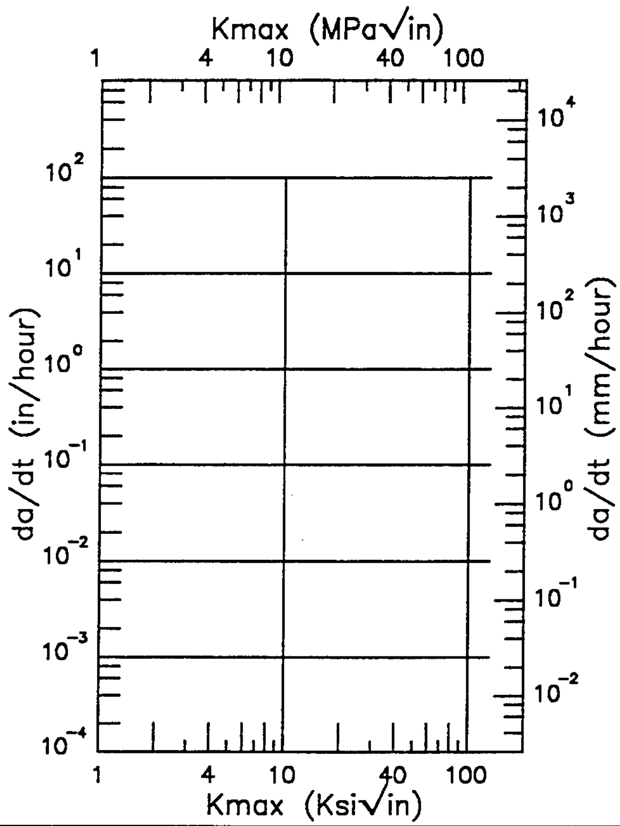
Figure 3.31.3.1.3

Condition/Ht:
Form:
Specimen Type: CNT
Orientation:
Yield Strength:
Ult. Strength:

Specimen Thk: 0.125 in.
Specimen Width:
A_O:
K_{Iscc}:
Ref: 84309

(1 of 1)





Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
17.50 (min)	13.0
20.	72.2
25.	516.
30.	1514.
35.	3219.
38.50 (max)	5155.

Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error	
>100.0	

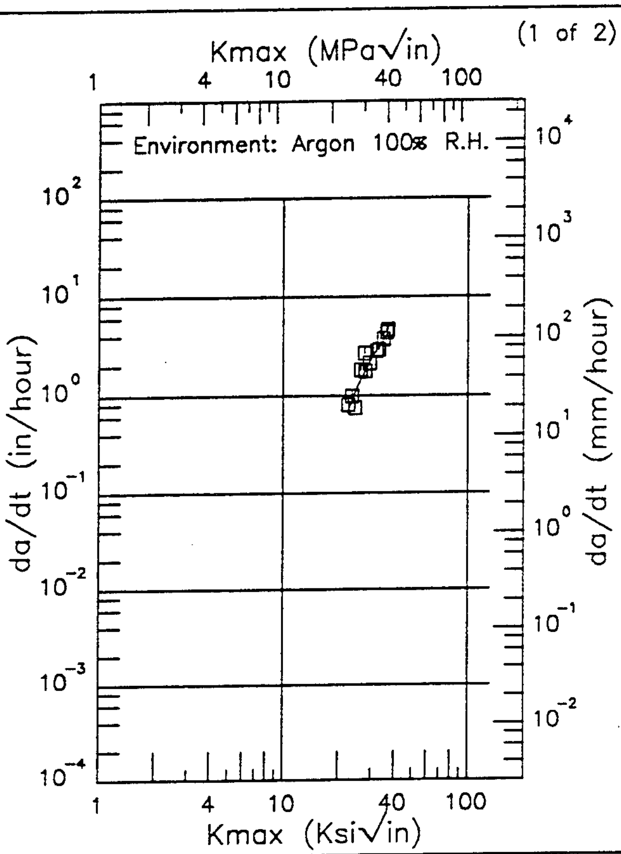
RMS % Error	

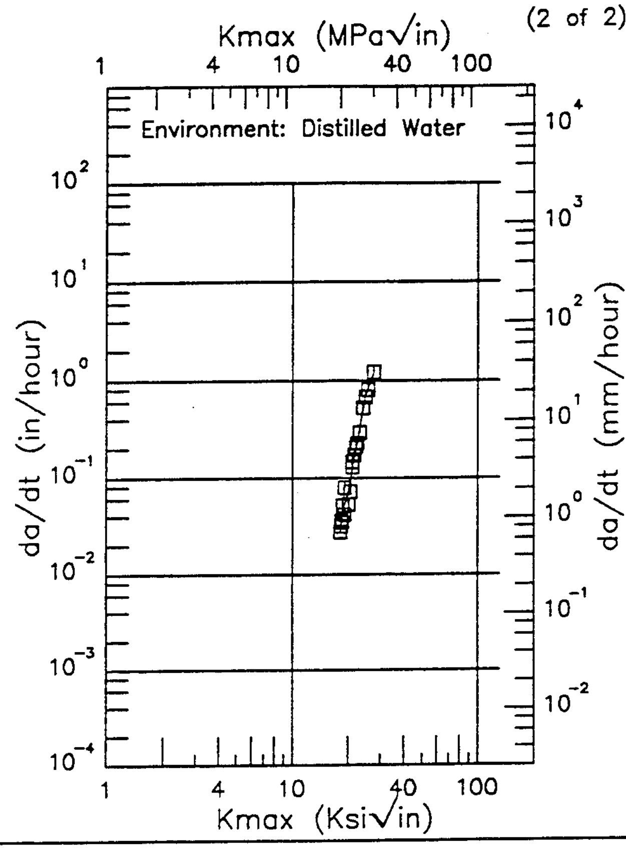
Figure 3.31.3.2.1

H11

Condition/Ht:
Form:
Specimen Type: CNT
Orientation:
Yield Strength: 230 ksi
Ult. Strength:

Specimen Thk: 0.08 in.
Specimen Width:
Ao:
KIscc:
Ref: 75111





Kmax (Ksi√in)	da/dt (10^{-3} in/hour)
22.50 (min)	674.
25.	1191.
30.	2363.
35.	3685.
37.00 (max)	4333.

Kmax (Ksi√in)	da/dt (10^{-3} in/hour)
18.10 (min)	35.8
20.	67.9
25.	708.
27.40 (max)	1175.

RMS % Error 20.66

RMS % Error 18.61

Figure 3.31.3.2.2

TABLE 3.31.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL H11

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1325°F; 1850°F 0.5hr AC; 1060°F 2+2hr	S	R.T.	---	205.6	Dist Water	CNT	2	0.05	0.08	---	---	35*	4000	1968	72283
					3N NaCl	CNT	2	0.05	0.08	---	---	28	20000	1968	72283
Quenched + Tempered at 1100°F	P	R.T.	---	188	3.5% NaCl	---	1.5	0.48	0.48	---	54	30	---	1971	84351

* specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 3.32.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL HP 9-4-.20 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} ($ksi\sqrt{in}$) Specimen Orientation L-T Mean K_{Ic}	L-T Std Dev	L-T n	T-L Mean K_{Ic}	T-L Std Dev	T-L n	S-L Mean K_{Ic}	S-L Std Dev	S-L n
Plate	1650F 1-2HR AC 1-2HR 1-2HR AC -100F 1.5HR 1025F 4HR 1060F 4HR	123.5	12.	2	---	---	---	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1025F 4-6HR	121.5	29.	2	---	---	---	---	---	---
Forging	1525F OQ -100F 1HR 1065F 4+4HR	---	---	---	111.7	2.	2	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-2HR 1025F 4HR	134.8	12.3	5	109.7	4.7	3	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1025F 4-6HR	135.2	11.6	15	125.3	1.8	6	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 2HR 1050F 4-6HR	133.2	3.9	5	---	---	---	---	---	---
	1650F 1-2HR ACX	125.5	3.5	2	---	---	---	---	---	---
	1650F 2HR AC 1525F 2HR OQ 1000F 2+2HR AC	94.4	4.4	3	---	---	---	---	---	---
	1650F 4.5HR AC TO 900F HELD 0.5HR AC -100F 1.5HR 1025F 8HR A-BQ	128.5	0.7	2	---	---	---	---	---	---

TABLE 3.32.1.1 (CONCLUDED)

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL HP 9-4-.20 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging (Cont'd)	1700F 4.5HR AC 1700F 1.5HR AC -100F 1.5HR 1025F 4HR	140.5	0.7	2	---	---	---	---	---	---
	ANNEALED	120.6	7.3	12	117.7	1.9	3	---	---	---
	HEAT TREATED	140.7	4.5	10	132.3	6.6	7	---	---	---
	Unspecified	150.6	4.5	2	136.3	16.8	2	---	---	---

TABLE 3.32.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: 100% Relative Humidity**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS AC -100F 2HRS 1025F 4HRS	PLATE	0.08	1			0.93	6.26		
	BILLET	0.08	0.1				6.63	38.47	
		0.08	1			0.65	6.45	42.25	
		0.3	1			0.98	8.45		
		0.5	1			1.51	8.02		

TABLE 3.32.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*) 2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	BAR	0.02	1					39.57	

TABLE 3.32.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS AC -100F 2HRS 1025F 4HRS	PLATE	0.08	0.1				8.73	64	253.71

TABLE 3.32.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS AC -100F 2HRS 1025F 4HRS	PLATE	0.08	6			0.87	4.85	29.81	
	BILLET	0.05	1				6.9	32.1	
		0.08	0.1				4.54	33.59	
		0.08	6				4.31	37.22	250.39
		0.08	9		0.13	0.78	5.89		
		0.5	6			0.82			
		0.7	6			1.27	8.13		
WELDED	WELDMENT	0.08	1				0.43	21.26	
		0.3	6				1.01	29.54	
		0.5	6				5.24	50.6	

TABLE 3.32.1.2.5

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.C.S.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-20			0.18	1.61	18.9	125.87
	BAR	0.02	10				3.58	33.15	

TABLE 3.32.1.2.6

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.C.S.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS AC -100F 2HRS 1025F 4HRS	BILLET	0.08	1			0.6	5.71		

TABLE 3.32.1.2.7

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-15					30.66	202.47

TABLE 3.32.1.2.8

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS AC -100F 2HRS 1025F 4HRS	PLATE	0.08	1				6.94		
	BILLET	0.08	1			0.74	5.26		

TABLE 3.32.1.2.9

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*) 2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS AC -100F 2HRS 1025F 4HRS	PLATE	0.08	1				4.92	28.04	
	BILLET	0.05	1					29.83	
		0.08	6				4.85		

TABLE 3.32.1.2.10

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-20			0.24	2.99	30.69	489.57

TABLE 3.32.1.2.11

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-15				2.41	31.39	319.63

TABLE 3.32.2.1

ALLOY STEEL HP 9-4-.20 K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 * (K_q/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_q (Ksi * $\sqrt{in.}$)	K_q MEAN	STAN DEV		
---	Forging	1.25	R.T.	L-T	196.5	3.995	2.000	CT	2.065	1.53	153.80	150.6	4.5	1977	MA005
		1.25			196.5	4.002	2.000	CT	2.118	1.40	147.39			1977	MA005
---	Forging	1.25	R.T.	T-L	198.0	4.000	1.998	CT	2.068	1.39	148.10	136.3	16.8	1977	MA005
		1.25			198.0	3.997	2.000	CT	2.070	0.98	124.40			1977	MA005
1525F OQ -100F 1HR 1065F 4+4HR	Forging	4.00	R.T.	T-L	179.0	3.996	1.497	CT	2.003	0.95	110.30	111.7	2.0	1974	90012
		4.00			179.0	3.995	1.498	CT	2.030	1.00	113.10			1974	90012
1650F 1-2 HR AC 1525F 1-2 HR OQ -100F 2 HR 1050F 4-6 HR	Forging	3.25	R.T.	L-T	184.0	5.248	1.506	CT	2.543	1.42	139.00	133.2	3.9	1973	86428
		3.00			186.0	4.495	1.505	CT	2.277	1.26	132.00			1973	86428
		3.25			189.0	4.499	1.502	CT	2.275	1.17	129.00			1973	86428
		3.25			189.0	5.245	1.511	CT	2.563	2.50	131.00			1973	86428
		3.25			190.0	4.500	1.501	CT	2.287	1.26	135.00			1973	86428
1650F 1-2HR AC 1525F 1-2 HR AC -100F 1-2 HR 1025F 4 HR	Forging	3.70	-65	L-T	190.0	6.000	2.000	CT	---	1.84	163.00	---	---	1974	90011
1650F 1-2HR AC 1525F 1-2 HR AC -100F 1-2 HR 1025F 4 HR	Forging	3.70	-65	T-L	190.0	6.000	2.000	CT	---	1.21	132.00	---	---	1974	90011
1650F 1-2HR AC 1525F 1-2 HR AC -100F 1-2 HR 1025F 4 HR	Forging	7.00	R.T.	L-T	190.0	5.999	1.995	CT	2.987	1.50	147.00	134.8	12.3	1973	85836
		4.00			190.0	5.997	1.752	CT	3.044	1.02	121.00			1973	85836
		4.00			190.0	5.999	1.756	CT	3.054	1.04	122.00			1973	85836
		7.00			190.0	6.000	1.997	CT	2.981	1.37	141.00			1973	85836
		7.00			190.0	6.002	1.991	CT	2.979	1.42	143.00			1973	85836
1650F 1-2HR AC 1525F 1-2 HR AC -100F 1-2 HR 1025F 4 HR	Forging	4.00	R.T.	T-L	190.0	6.000	1.757	CT	3.077	0.80	108.00	109.7	4.7	1973	85836
		4.00			190.0	5.999	1.755	CT	3.071	0.78	106.00			1973	85836
		7.00			190.0	6.005	1.992	CT	3.006	0.92	115.00			1973	85836

TABLE 3.32.2.1 (CONTINUED)

ALLOY STEEL HP 9-4-.20 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
1650F 1-2HR AC 1-2 HR AC -100F 1.5 HR 1025F 4 HR 1060F 6 HR	Plate	2.50	R.T.	L-T	189.0	6.000	2.000	CT	---	1.22	132.00	123.5	12.0	1974	90011
		2.50			189.0	6.000	2.000	CT	---	0.92	115.00			1974	90011
1650F 1-2HR AC 1-2 HR AC -100F 1.5 HR 1025F 4 HR 1060F 6 HR	Plate	2.50	R.T.	T-L	189.0	6.000	2.000	CT	---	1.15	128.00	---	---	1974	90011
1650F 1-2HR AC 1.5 HR OQ 1025F 12 HR	Forging	4.00	R.T.	L-T	185.0	6.006	1.585	CT	2.987	1.10	123.00	125.5	3.5	1973	85836
		4.00			185.0	6.007	1.546	CT	2.996	1.19	128.00			1973	85836
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1000F 4-6 HR	Forging	3.00	R.T.	L-T	190.0	6.000	2.000	CT	---	1.34	139.00	---	---	1974	90011
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Plate	2.50	-65	L-T	195.0	6.000	2.000	CT	---	0.54	91.00	100.4	9.2	1974	90011
		2.50			195.0	6.000	2.000	CT	---	0.75	107.00			1974	90011
		2.50			195.0	6.000	2.000	CT	---	0.53	90.00			1974	90011
		2.50			195.0	6.000	2.000	CT	---	0.72	105.00			1974	90011
		2.50			195.0	6.000	2.000	CT	---	0.78	109.00			1974	90011
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Plate	2.50	-65	T-L	195.0	6.000	2.000	CT	---	0.71	104.00	97.3	6.1	1974	90011
		2.50			195.0	6.000	2.000	CT	---	0.56	92.00			1974	90011
		2.50			195.0	6.000	2.000	CT	---	0.60	96.00			1974	90011
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Plate	2.50	R.T.	L-T	189.0	6.000	2.000	CT	---	0.71	101.00	121.5	29.0	1974	90011
		2.50			190.0	6.000	2.002	CT	2.905	1.53	142.00			1972	84306
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Plate	2.50	R.T.	T-L	186.0	6.000	2.000	CT	---	0.97	116.00	---	---	1974	90011
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Forging	3.70	-65	L-T	190.0	5.997	1.507	CT	2.991	1.12	127.00	---	---	1973	85836

TABLE 3.32.2.1 (CONTINUED)

ALLOY STEEL HP 9-4-.20 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
		4.00			186.0	6.000	2.010	CT	2.986	1.27	136.00			1973	85836
		4.00			186.0	5.998	2.010	CT	2.975	1.42	143.00			1973	85836
		4.00			186.0	6.002	2.010	CT	2.985	1.28	136.00			1973	85836
		4.00			186.0	6.000	2.005	CT	2.964	1.36	140.00			1973	85836
		4.00			186.0	6.003	2.010	CT	2.963	1.32	138.00			1973	85836
		4.00			186.0	6.005	2.010	CT	2.984	1.32	138.00			1973	85836
		4.00			188.0	6.000	2.000	CT	---	1.90	164.00			1974	90011
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Forging	4.00	R.T.	L-T	194.0	4.014	1.506	CT	1.967	1.33	141.00	135.2	11.6	1972	84306
		4.00			194.0	4.000	1.635	CT	1.970	1.39	142.00			1972	84306
		4.00			194.0	3.994	1.598	CT	2.366	1.26	135.00			1972	84306
		4.00			198.0	5.000	2.000	CT	---	0.84	115.00			1974	90011
		4.00			198.0	5.000	2.000	CT	---	0.93	121.00			1974	90011
		4.00			198.0	5.000	2.000	CT	---	0.96	123.00			1974	90011
		4.00			198.0	5.000	2.000	CT	---	1.01	126.00			1974	90011
		4.00			198.0	5.000	2.000	CT	---	1.08	130.00			1974	90011
		4.00			190.0	6.000	2.011	CT	2.977	1.11	126.00			1973	85836
		4.00			190.0	6.006	2.006	CT	2.970	1.10	126.00			1973	85836
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Forging	4.00	R.T.	T-L	190.0	6.002	2.004	CT	2.963	1.11	127.00	125.3	1.8	1973	85836
		4.00			190.0	6.002	2.010	CT	2.961	1.03	122.00			1973	85836
		4.00			190.0	6.005	2.010	CT	2.959	1.11	126.00			1973	85836
		4.00			194.0	4.013	1.506	CT	1.991	1.07	125.00			1972	84306

TABLE 3.32.2.1 (CONTINUED)

ALLOY STEEL HP 9-4-.20 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Forging	4.00	R.T.	S-T	190.0	3.003	1.632	CT	1.496	0.89	114.00	115.0	1.4	1973	85836
		4.00			190.0	3.005	1.630	CT	1.484	0.93	116.00			1973	85836
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Forging	4.00	82	L-T	190.0	6.000	1.740	CT	2.983	1.01	121.00	126.0	7.1	1973	85836
		4.00			190.0	6.000	1.743	CT	2.971	1.19	131.00			1973	85836
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1025F 4-6 HR	Forging	4.00	82	T-L	185.0	6.001	1.752	CT	3.000	0.95	114.00	---	---	1973	85836
1650F 1-2HR AC 1525F 1-2 HR OQ -100F 2 HR 1050F 4-6 HR	Forging	1.70	R.T.	T-L	190.0	5.260	1.501	CT	2.628	1.43	143.00	---	---	1973	86428
1650F 2HR AC 1525F 2 HR OQ 1000F 2+2 HR AC	Forging	4.00	R.T.	L-T	186.0	2.510	1.247	CT	1.146	0.60	91.10	94.4	4.4	1974	88136
		4.00			186.0	2.523	1.244	CT	1.136	0.72	99.40			1974	88136
		4.00			186.0	2.516	1.240	CT	1.171	0.63	92.80			1974	88136
1650F 4.5HR AC TO 900F HELD 0.5HR AC -100F 1.5HR 1025F 8HR A-BQ	Forging	4.00	R.T.	L-T	185.0	6.004	1.609	CT	3.020	1.19	128.00	128.5	0.7	1973	85836
		4.00			185.0	6.000	1.590	CT	3.031	1.22	129.00			1973	85836
1700F 4.5HR AC 1700F 1.5HR AC -100F 1.5 HR 1025F 4 HRS	Forging	4.00	R.T.	L-T	185.0	6.003	1.596	CT	3.006	1.45	141.00	140.5	0.7	1973	85836
		4.00			185.0	6.005	1.605	CT	3.031	1.43	140.00			1973	85836
ANNEALED	Forging	3.00	R.T.	L-T	189.0	2.003	0.997	CT	1.041	0.80	107.30	120.6	7.3	1977	NC001
		3.00			189.0	3.000	0.998	CT	1.522	0.94	116.10			1977	NC001
		3.00			189.0	4.005	2.001	CT	2.049	1.00	120.00			1977	NC001
		3.00			189.0	4.009	1.504	CT	2.038	1.15	128.39			1977	NC001
		3.00			189.0	2.000	0.998	CT	1.037	0.94	116.00			1977	NC001
		3.00			189.0	3.001	1.503	CT	1.531	0.97	118.30			1977	NC001
		3.00			189.0	4.005	2.001	CT	2.068	0.96	117.69			1977	NC001
		3.00			189.0	4.000	1.505	CT	2.033	0.99	119.19			1977	NC001

TABLE 3.32.2.1 (CONCLUDED)

ALLOY STEEL HP 9-4-.20 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
ANNEALED Cont'd	Forging Cont'd	3.00	R.T. Cont'd	L-T Cont'd	189.0	3.000	1.504	CT	1.529	0.93	115.40	Cont'd	Cont'd	1977	NC001
		3.00			192.0	3.995	2.000	CT	2.033	1.19	132.50			1976	NC001
		3.00			192.0	3.996	1.999	CT	2.013	1.13	129.30			1976	NC001
		3.00			192.0	3.992	2.000	CT	2.059	1.09	127.30			1976	NC001
ANNEALED	Forging	3.00	R.T.	T-L	190.0	3.998	2.000	CT	2.012	0.96	118.30	117.7	1.9	1976	NC001
		3.00			190.0	3.998	2.000	CT	2.028	0.92	115.60			1976	NC001
		3.00			190.0	3.995	2.000	CT	2.080	0.98	119.30			1976	NC001
HEAT TREATED	Forging	3.40	R.T.	L-T	185.0	4.003	1.501	CT	1.954	1.33	135.00	140.7	4.5	1973	85879
		4.00			189.0	4.000	1.503	CT	2.037	1.48	145.00			1973	85633
		4.00			190.0	3.980	1.505	CT	2.039	1.35	139.00			1973	85633
		4.00			190.0	3.999	1.504	CT	2.030	1.45	145.00			1973	85633
		4.00			190.0	3.971	1.506	CT	2.049	1.35	139.00			1973	85633
		4.00			190.0	3.995	1.504	CT	2.036	1.34	139.00			1973	85633
		4.00			191.0	4.000	1.504	CT	2.026	1.30	138.00			1973	85633
		4.00			192.0	4.004	1.503	CT	2.031	1.30	138.00			1973	85633
		4.00			192.0	4.002	1.504	CT	2.034	1.33	139.00			1973	85633
		7.00			198.0	3.990	1.511	CT	2.053	1.46	150.00			1973	85857
HEAT TREATED	Forging	6.60	R.T.	T-L	186.0	3.984	1.499	CT	2.026	1.46	142.00	132.3	6.6	1973	85857
		3.40			187.0	4.004	1.502	CT	2.011	1.22	131.00			1973	85879
		3.40			187.0	4.000	1.501	CT	1.985	1.22	131.00			1973	85879
		3.40			190.0	4.005	1.499	CT	2.021	1.36	140.00			1973	85879
		3.40			196.0	4.002	1.484	CT	2.054	1.12	131.00			1973	85857
		7.00			198.0	3.986	1.507	CT	2.038	1.07	128.00			1973	85857
		7.00			198.0	3.989	1.464	CT	2.033	0.97	123.00			1973	85857

HP9-4-.20

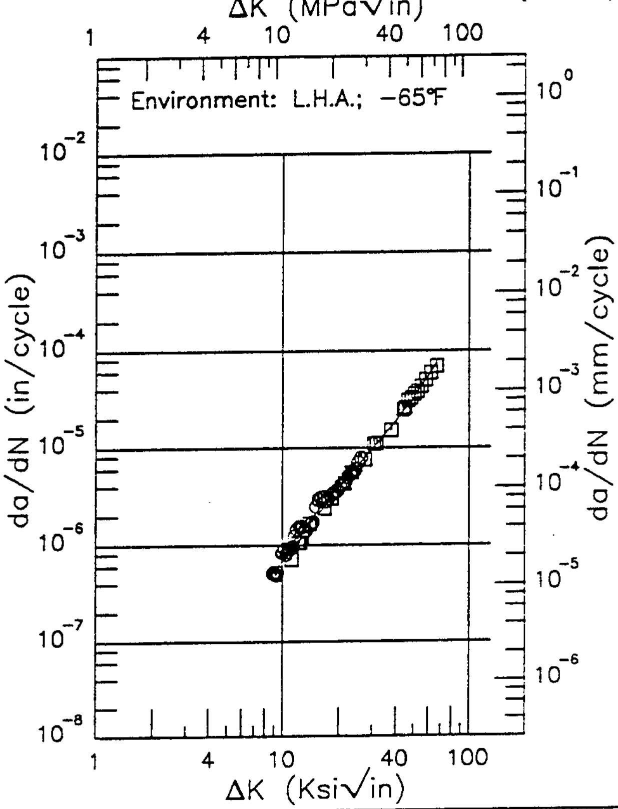
E

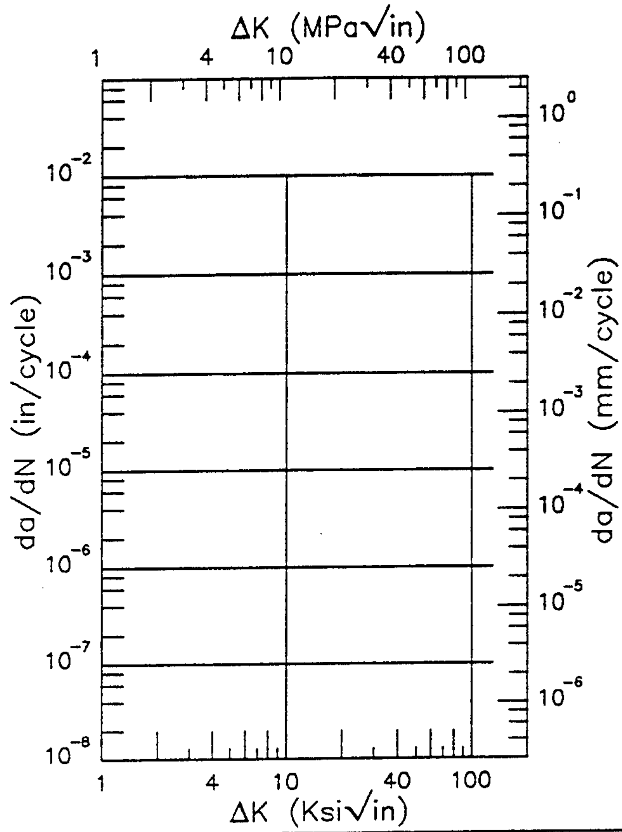
Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS

Form: 2.5 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 1 Hz

Yield Strength: 188 - 189 ksi
Ult. Strength: 200 - 201 ksi
Specimen Thk: 0.993 - 1 in.
Specimen Width: 7.4 in.
Ref: 88579;85837

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.84 (min)	0.498
9.	0.527
10.	0.724
13.	1.48
16.	2.44
20.	4.04
25.	6.55
30.	9.73
35.	13.7
40.	18.7
50.	32.8
60.	54.4
66.62 (max)	74.6

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
10.79	☐ ○ 0. .5 .8 1.25 2.

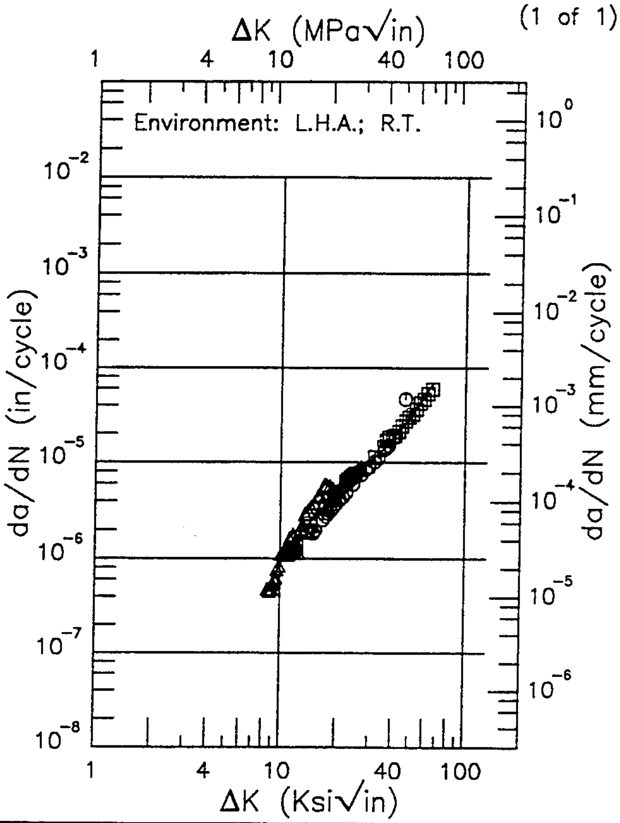
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.32.3.1.1

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 2.5 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 6 Hz

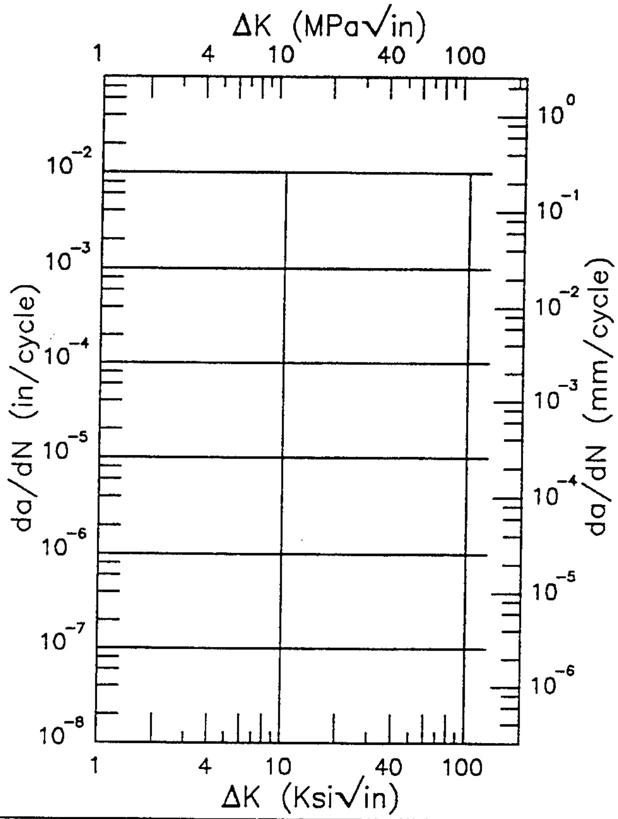
Yield Strength: 188 - 189 ksi
Ult. Strength: 200 - 201 ksi
Specimen Thk: 0.83 - 1 in.
Specimen Width: 5.99 - 7.4 in.
Ref: 88579

(1 of 1)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.50 (min)	0.480
9.	0.599
10.	0.872
13.	1.90
16.	3.10
20.	4.85
25.	7.26
30.	10.0
35.	13.4
40.	17.6
50.	29.8
60.	50.1
65.72 (max)	67.5

RMS % Error	Life Prediction Ratio Summary
21.16	0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.32.3.1.2

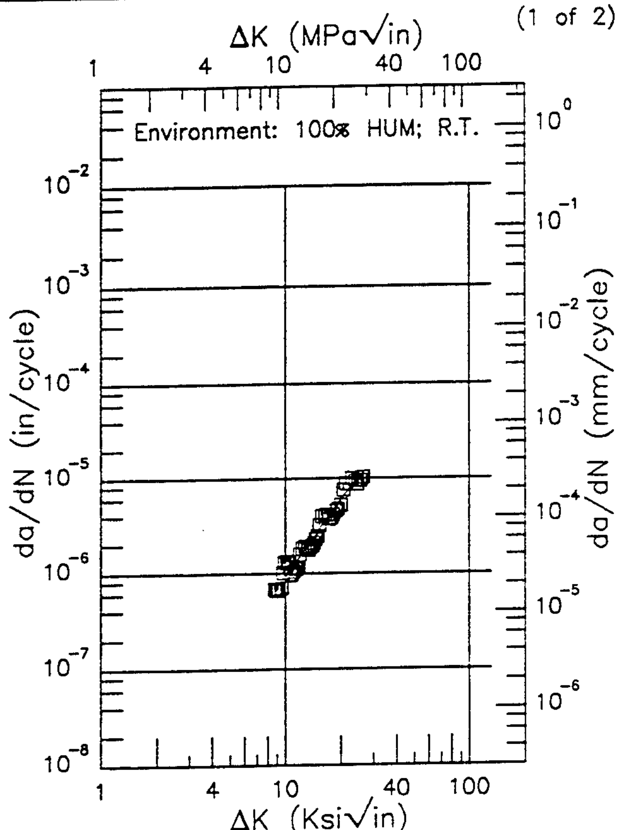
E

HP9-4-.20

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 2.5 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 1 Hz

Yield Strength: 188 - 191 ksi
Ult. Strength: 200 - 201 ksi
Specimen Thk: 0.994 - 0.996 in.
Specimen Width: 7.4 in.
Ref: 85837;88579

(1 of 2)

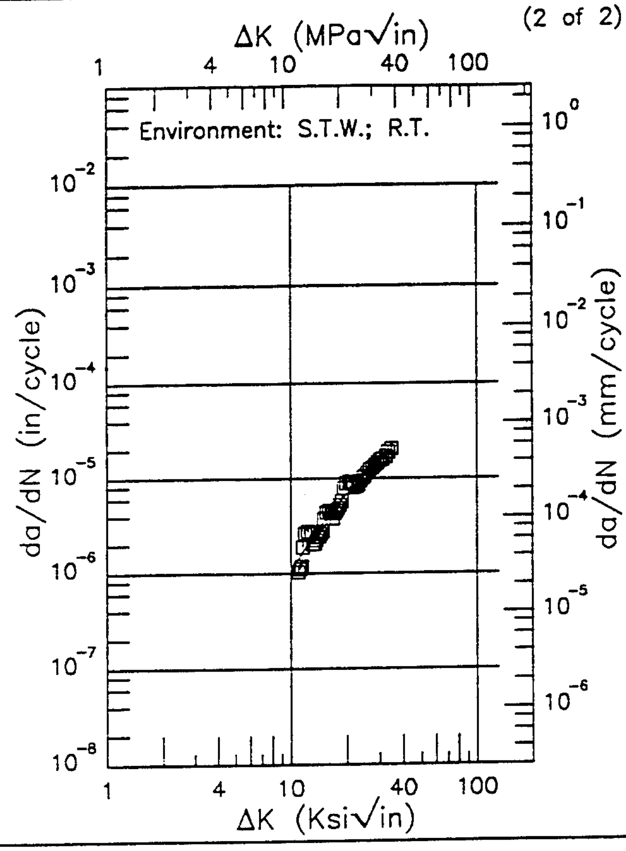


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.69 (min)	0.711
9.	0.755
10.	0.932
13.	1.84
16.	3.37
20.	6.26
25.	10.2
26.15 (max)	11.0

RMS % Error
15.68

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.00 (min)	1.43
13.	2.34
16.	4.08
20.	6.94
25.	11.1
30.	15.4
34.39 (max)	19.3

RMS % Error
16.28

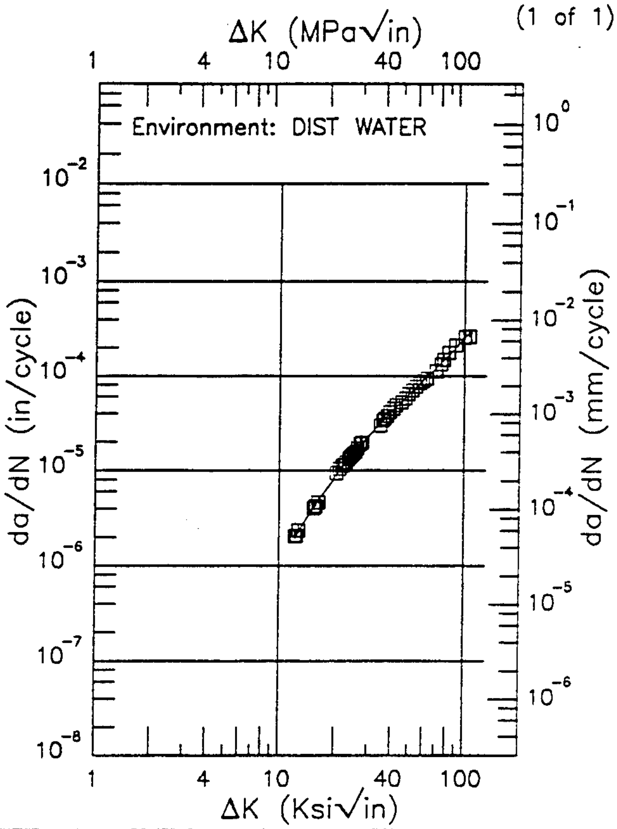
Life Prediction Ratio Summary
0. .5 .8 1.25 2.

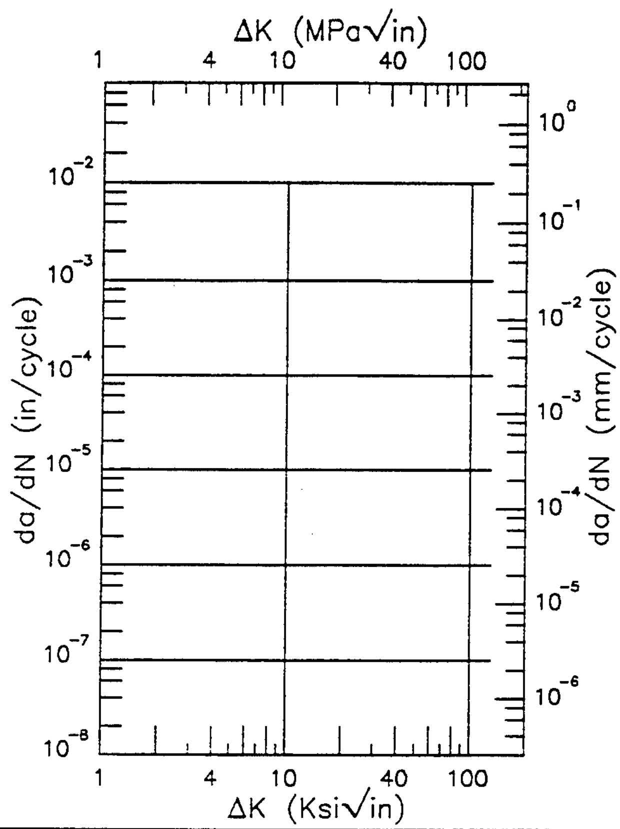
Figure 3.32.3.1.3

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 2.5 in. Plate
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 0.1 Hz

Yield Strength: 189 ksi
Ult. Strength: 201 ksi
Specimen Thk: 0.99 in.
Specimen Width: 7.41 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.13 (min)	1.92
13.	2.43
16.	4.68
20.	8.73
25.	15.2
30.	22.9
35.	31.7
40.	41.4
50.	64.0
60.	90.8
70.	122.
80.	159.
90.	203.
100.	254.
106.00 (max)	288.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
3.80	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.32.3.1.4

E HP9-4-.20

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS

Form: 2.5 in. Plate

Specimen Type: CT

Orientation: T-L

Stress Ratio: 0.08

Frequency: 1 Hz

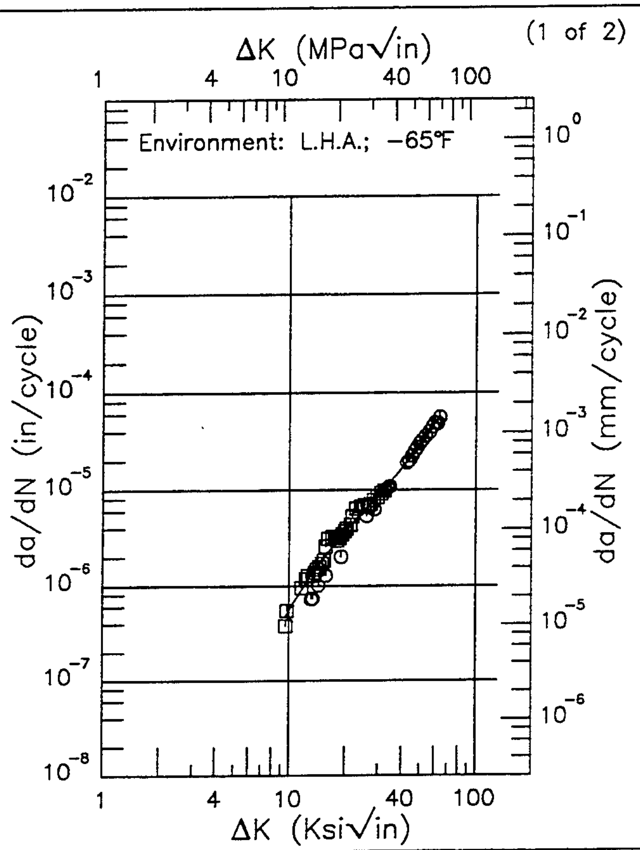
Yield Strength: 188 ksi

Ult. Strength: 199 - 200 ksi

Specimen Thk: 0.99 - 0.993 in.

Specimen Width: 6 - 7.4 in.

Ref: 85837;88579

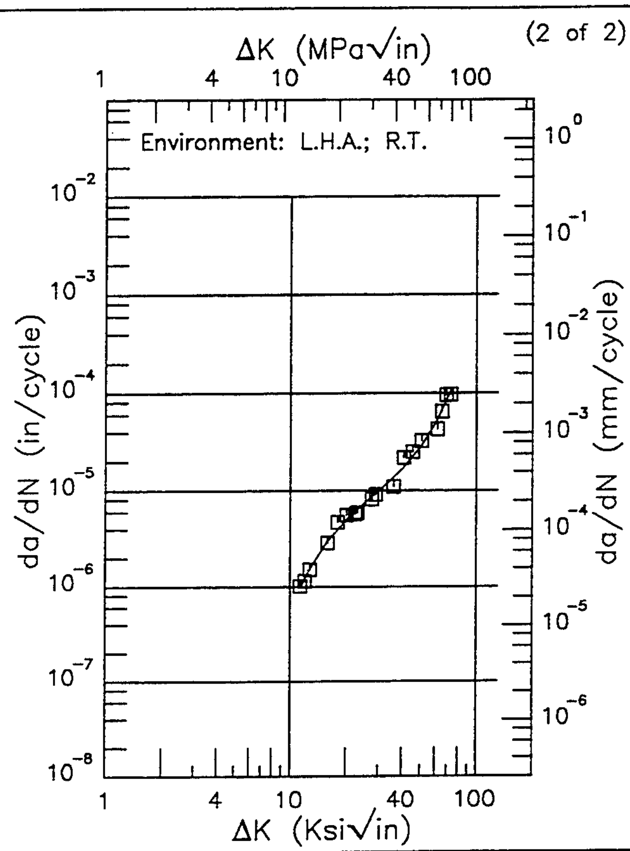


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.54 (min)	0.471
10.	0.555
13.	1.26
16.	2.19
20.	3.70
25.	6.00
30.	8.82
35.	12.3
40.	16.6
50.	28.7
60.	47.6
63.48 (max)	56.4

RMS % Error 16.91

Life Prediction Ratio Summary

0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.34 (min)	0.997
13.	1.64
16.	3.00
20.	4.92
25.	7.34
30.	9.91
35.	12.9
40.	16.7
50.	28.0
60.	48.6
70.	87.1
72.79 (max)	103.

RMS % Error 12.18

Life Prediction Ratio Summary

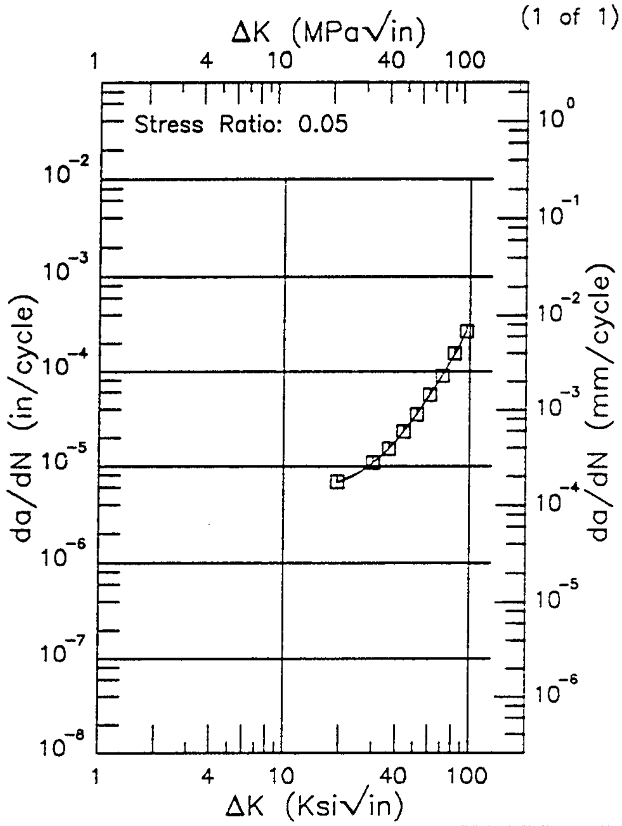
0. .5 .8 1.25 2.

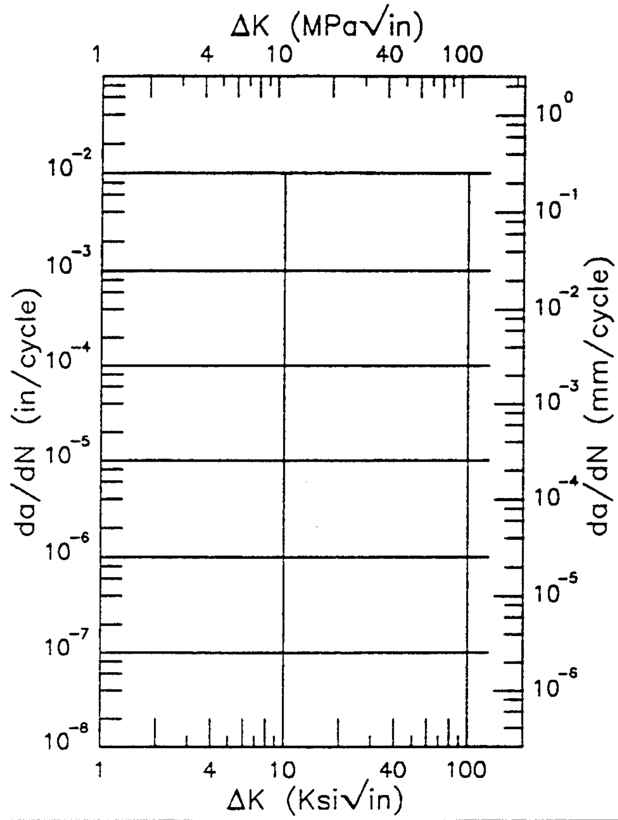
Figure 3.32.3.1.5

Condition/Ht: 1525F 2HRS AC −100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: L−T
Frequency: 1 Hz
Environment: L.H.A.; RT

Yield Strength: 188 ksi
Ult. Strength: 204 ksi
Specimen Thk: 1.99 in.
Specimen Width: 5.99 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.41 (min)	6.79
20.	6.90
25.	8.40
30.	10.8
35.	14.1
40.	18.6
50.	32.1
60.	53.9
70.	87.6
80.	138.
90.	212.
95.59 (max)	266.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
0.99	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.32.3.1.6

R

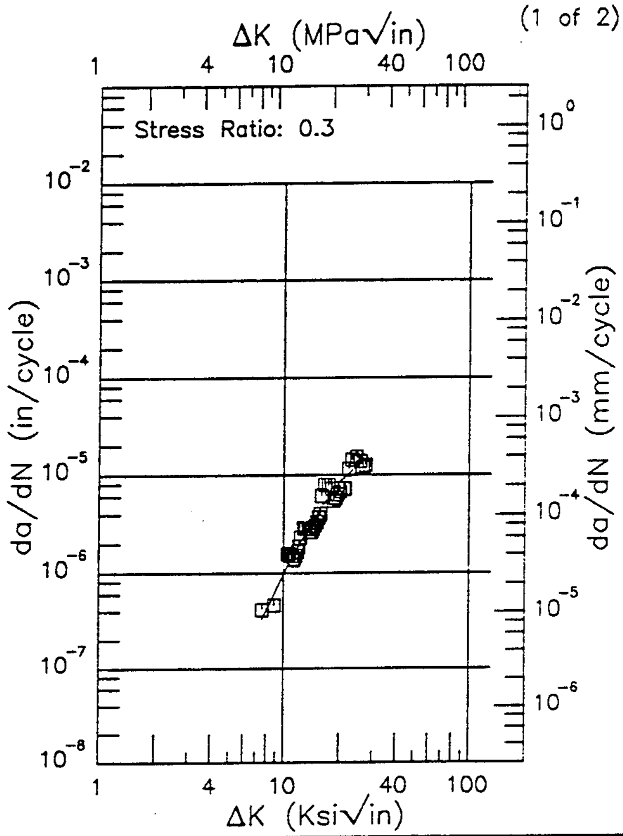
HP9-4-.20

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS

Form: 4 in. Billet
Specimen Type: CT
Orientation: L-T
Frequency: 1 Hz
Environment: 100% HUM; RT

Yield Strength: 189 ksi
Ult. Strength: 203 ksi
Specimen Thk: 0.986 - 0.987 in.
Specimen Width: 7.4 in.
Ref: 85837

(1 of 2)



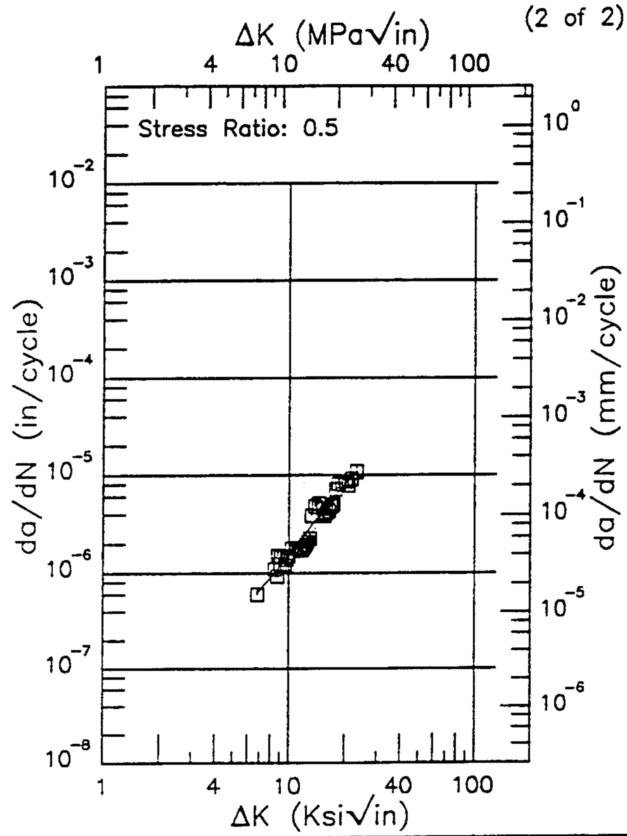
ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
7.60 (min)	0.331
8.	0.408
9.	0.652
10.	0.980
13.	2.51
16.	4.80
20.	8.45
25.	12.7
27.39 (max)	14.2

RMS % Error 19.90

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
6.77 (min)	0.631
7.	0.674
8.	0.893
9.	1.17
10.	1.51
13.	2.91
16.	4.85
20.	8.02
23.21 (max)	10.7

RMS % Error 18.07

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

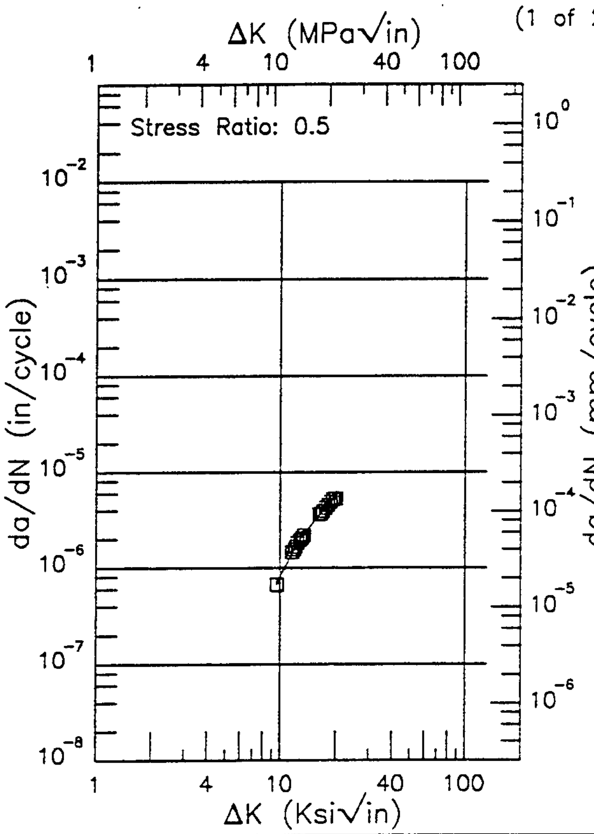
Figure 3.32.3.1.7

HP9-4-.20 R

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: L.H.A.; RT

Yield Strength: 186 - 189 ksi
Ult. Strength: 203 - 211 ksi
Specimen Thk: 0.991 - 0.997 in.
Specimen Width: 6 - 6.01 in.
Ref: 85837

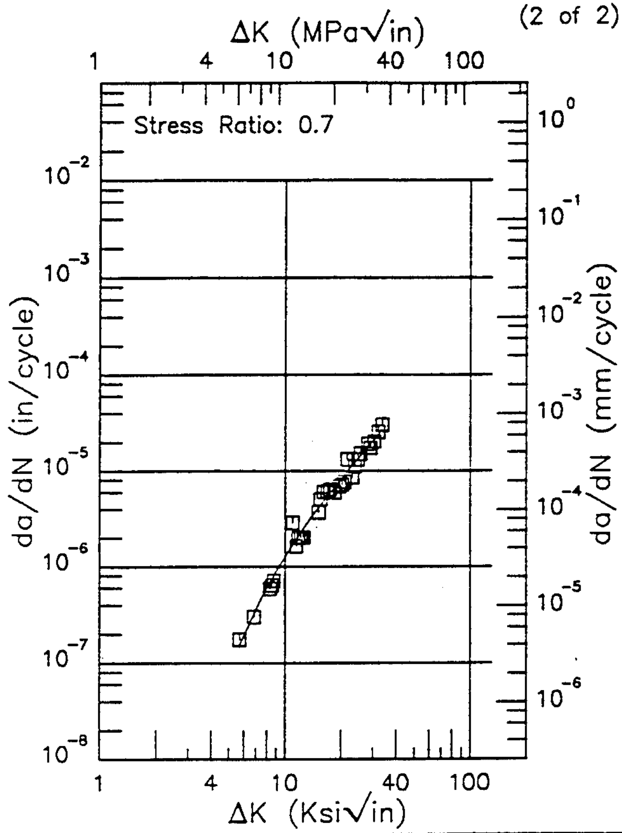
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
9.59 (min)	0.674
10.	0.819
13.	2.07
16.	3.43
19.92 (max)	5.62

RMS % Error	Life Prediction Ratio Summary
3.52	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
5.66 (min)	0.150
6.	0.194
7.	0.365
8.	0.602
9.	0.906
10.	1.27
13.	2.75
16.	4.73
20.	8.13
25.	13.6
30.	20.7
33.41 (max)	26.7

RMS % Error	Life Prediction Ratio Summary
19.29	0. .5 .8 1.25 2.

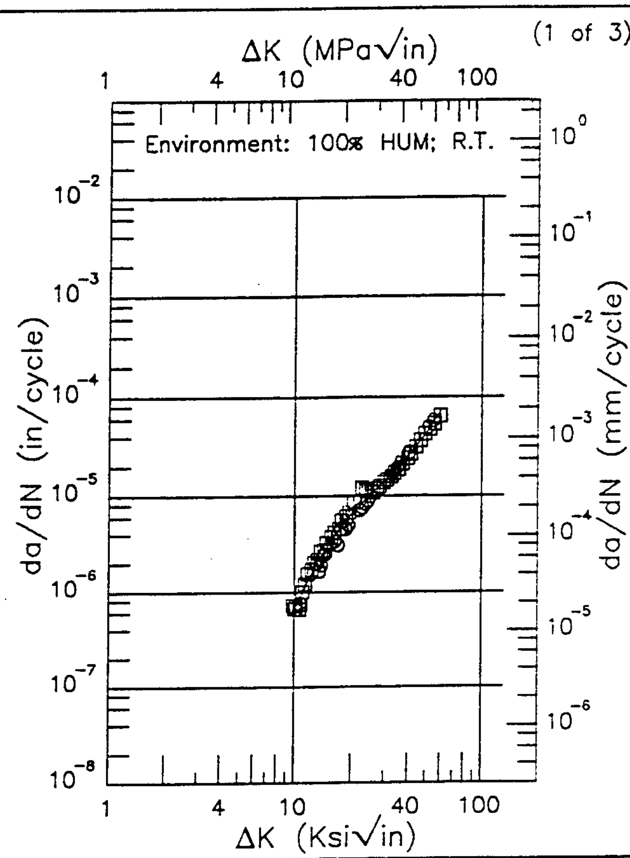
Figure 3.32.3.1.8

E

HP9-4-.20

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS	
Form: 4 in. Billet	Yield Strength: 176 - 189 ksi
Specimen Type: CT	Ult. Strength: 201 - 211 ksi
Orientation: L-T	Specimen Thk: 0.989 - 1 in.
Stress Ratio: 0.08	Specimen Width: 6 in.
Frequency: 1 Hz	Ref: 85837;88579

(1 of 3)



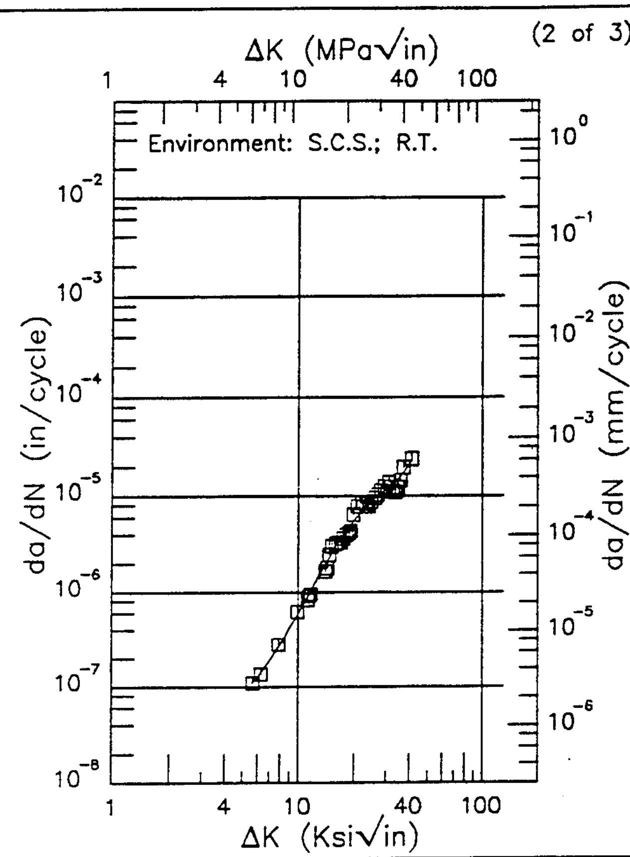
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.79 (min)	0.588
10.	0.652
13.	1.94
16.	3.72
20.	6.45
25.	10.1
30.	14.2
35.	19.1
40.	25.0
50.	42.2
59.72 (max)	71.0

RMS % Error 12.28

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.66 (min)	0.111
6.	0.126
7.	0.188
8.	0.281
9.	0.415
10.	0.598
13.	1.51
16.	3.02
20.	5.71
25.	8.97
30.	11.7
35.	15.2
40.	21.3
41.08 (max)	23.2

RMS % Error 11.74

Life Prediction Ratio Summary

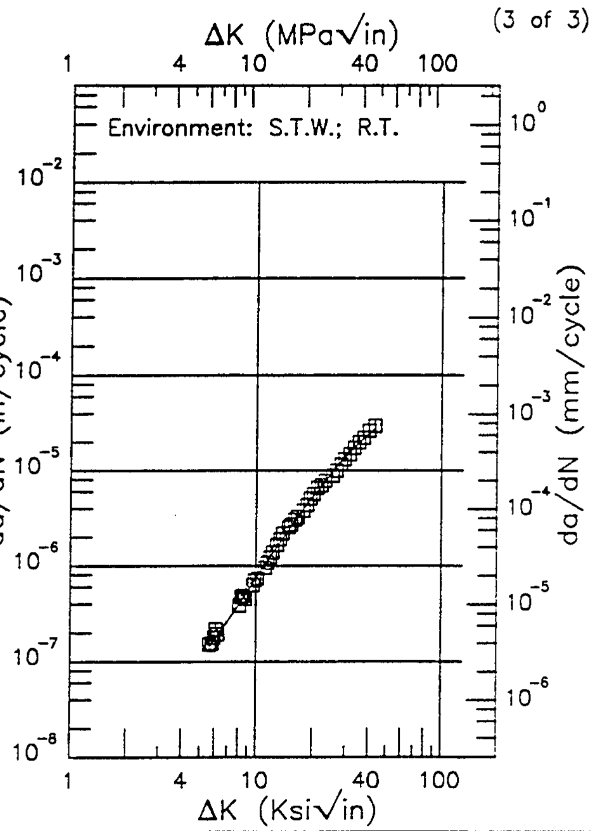
0. .5 .8 1.25 2.

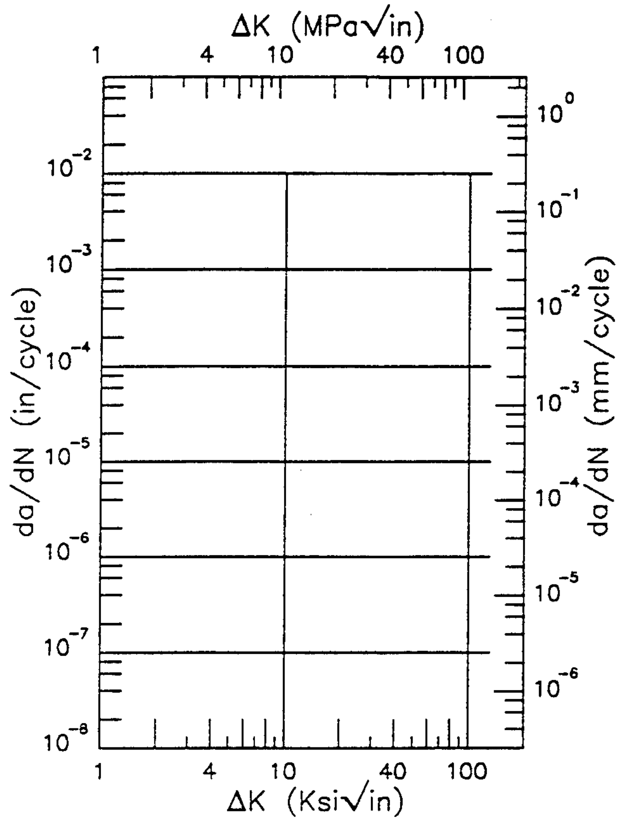
Figure 3.32.3.1.9

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 1 Hz

Yield Strength: 176 - 189 ksi
Ult. Strength: 201 - 211 ksi
Specimen Thk: 0.989 - 1 in.
Specimen Width: 6 in.
Ref: 85837;88579

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
5.62 (min)	0.144
6.	0.172
7.	0.265
8.	0.388
9.	0.546
10.	0.742
13.	1.59
16.	2.87
20.	5.26
25.	9.23
30.	14.0
35.	19.2
40.	24.4
43.29 (max)	27.8

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
6.45	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

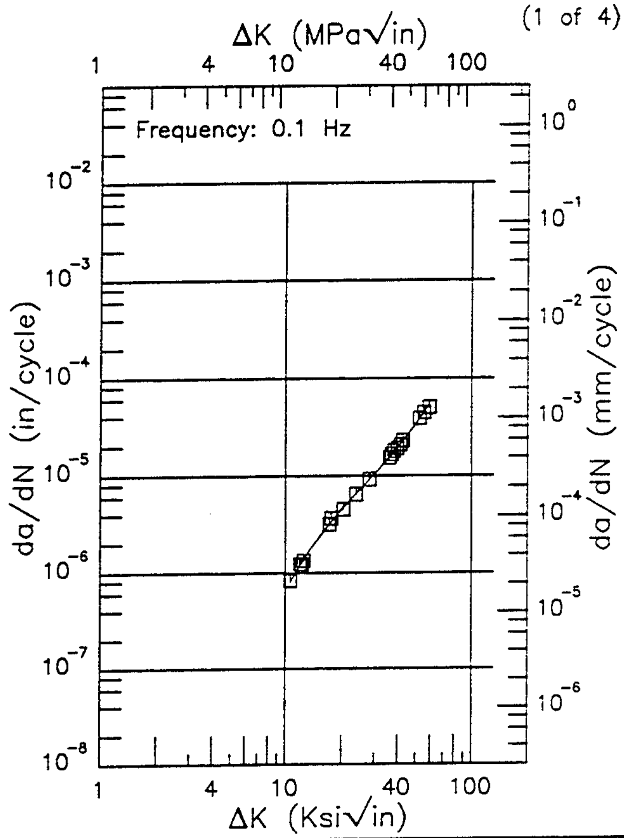
Figure 3.32.3.1.9 (Concluded)

F HP9-4-.20

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Environment: L.H.A.;-65°F - RT

Yield Strength: 176 - 189 ksi
Ult. Strength: 201 - 211 ksi
Specimen Thk: 0.989 - 1 in.
Specimen Width: 6 - 6.01 in.
Ref: 88579;85837

(1 of 4)



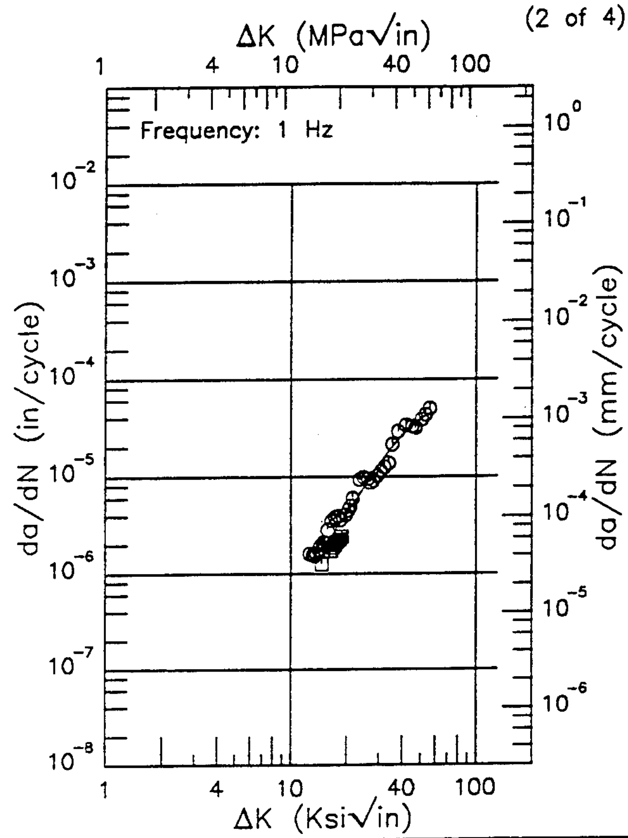
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.61 (min)	0.810
13.	1.55
16.	2.71
20.	4.54
25.	7.24
30.	10.5
35.	14.4
40.	19.4
50.	33.6
58.49 (max)	52.6

RMS % Error 3.27

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.61 (min)	1.36
13.	1.44
16.	2.25
20.	4.08
25.	7.80
30.	13.2
35.	19.8
40.	26.9
50.	39.4
55.93 (max)	44.0

RMS % Error 20.74

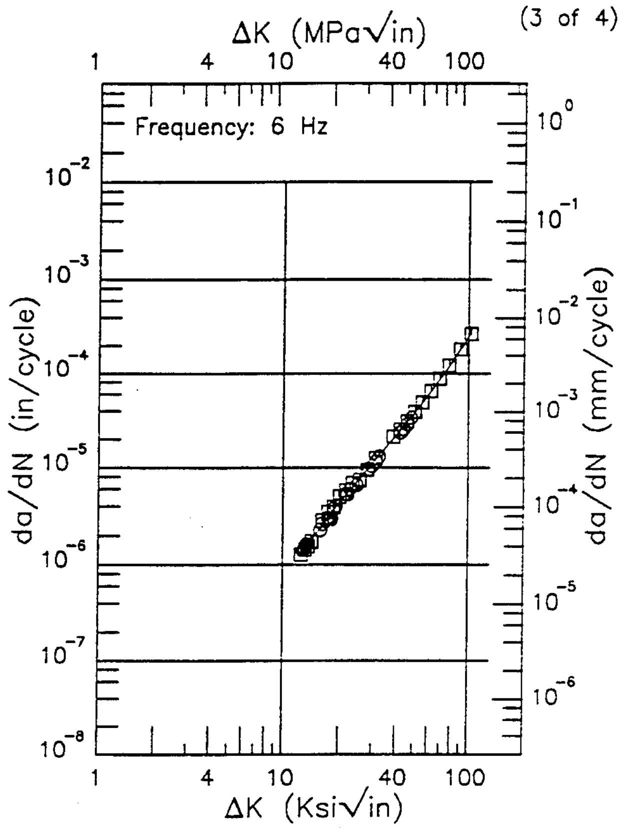
Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.32.3.1.10

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Environment: L.H.A.;-65°F - RT

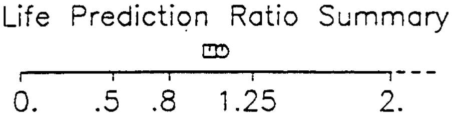
Yield Strength: 176 - 189 ksi
Ult. Strength: 201 - 211 ksi
Specimen Thk: 0.989 - 1 in.
Specimen Width: 6 - 6.01 in.
Ref: 88579;85837

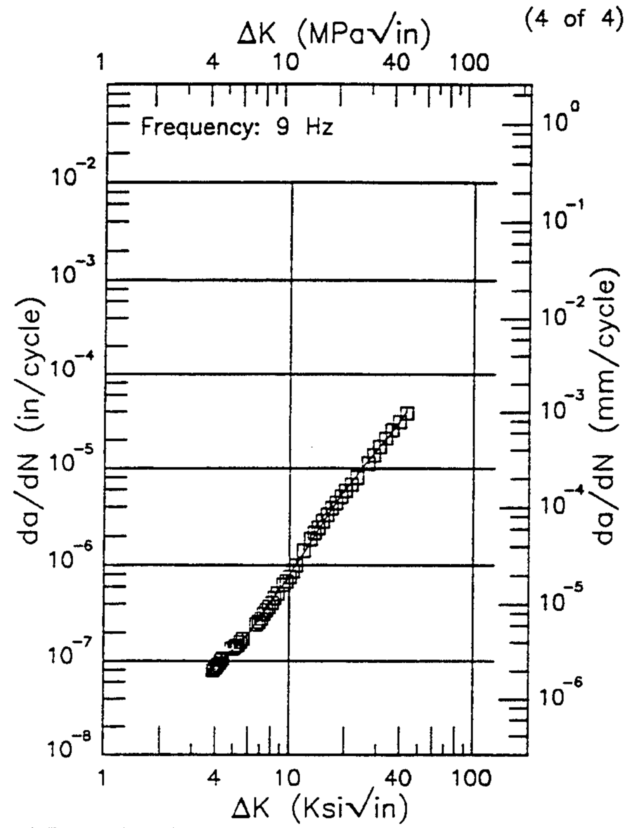


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.52 (min)	1.28
13.	1.42
16.	2.47
20.	4.31
25.	7.33
30.	11.2
35.	16.0
40.	21.8
50.	37.2
60.	58.8
70.	88.4
80.	128.
90.	181.
100.	250.
102.55 (max)	271.

RMS % Error: 5.78

Life Prediction Ratio Summary





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.86 (min)	0.0844
4.	0.0886
5.	0.130
6.	0.194
7.	0.286
8.	0.410
9.	0.574
10.	0.781
13.	1.71
16.	3.16
20.	5.89
25.	10.3
30.	15.6
35.	22.5
40.	32.2
43.08 (max)	40.4

RMS % Error: 4.03

Life Prediction Ratio Summary

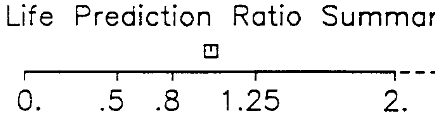


Figure 3.32.3.1.10 (Concluded)

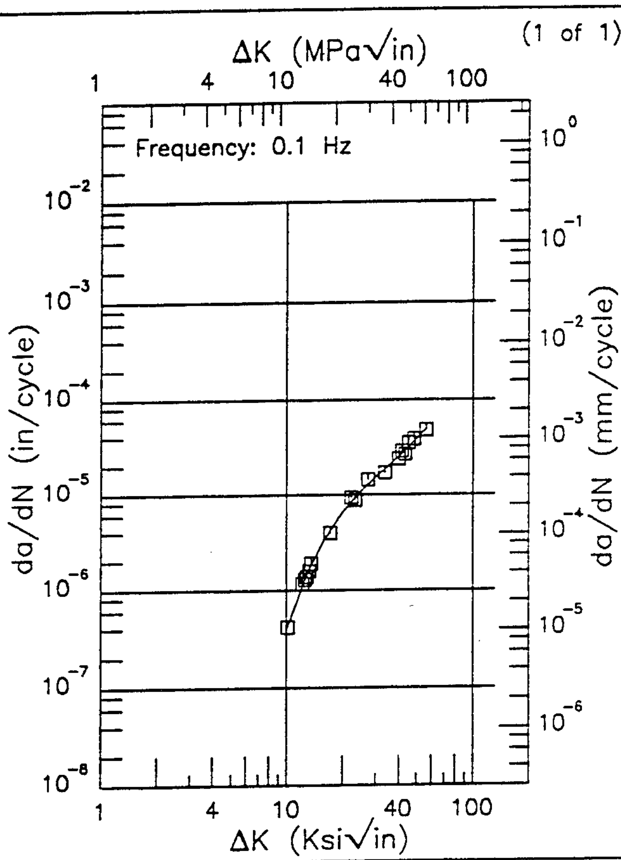
F

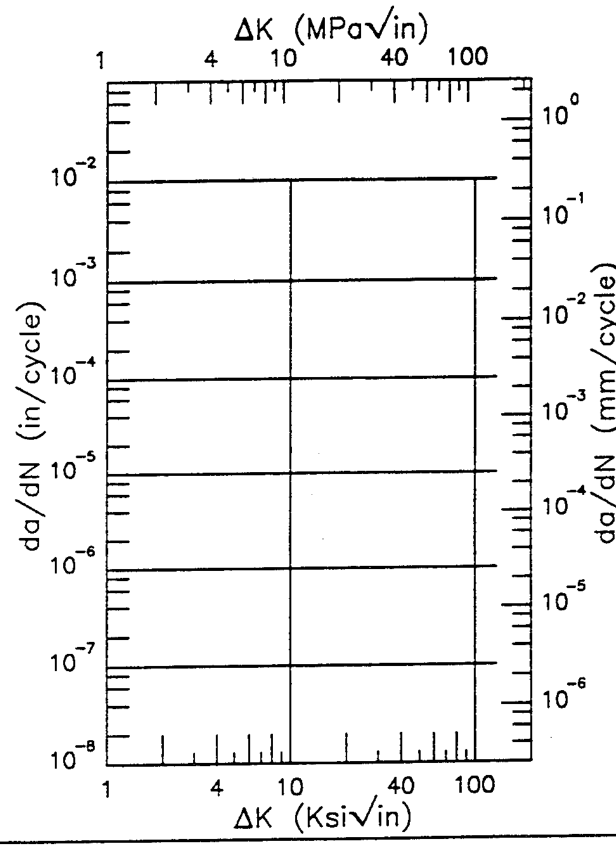
HP9-4-.20

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Environment: 100% HUM; RT

Yield Strength: 186 ksi
Ult. Strength: 211 ksi
Specimen Thk: 1 in.
Specimen Width: 6 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
10.13 (min)	0.423
13.	1.54
16.	3.44
20.	6.63
25.	11.0
30.	15.4
35.	20.1
40.	25.2
50.	38.5
55.79 (max)	49.0

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
7.30	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

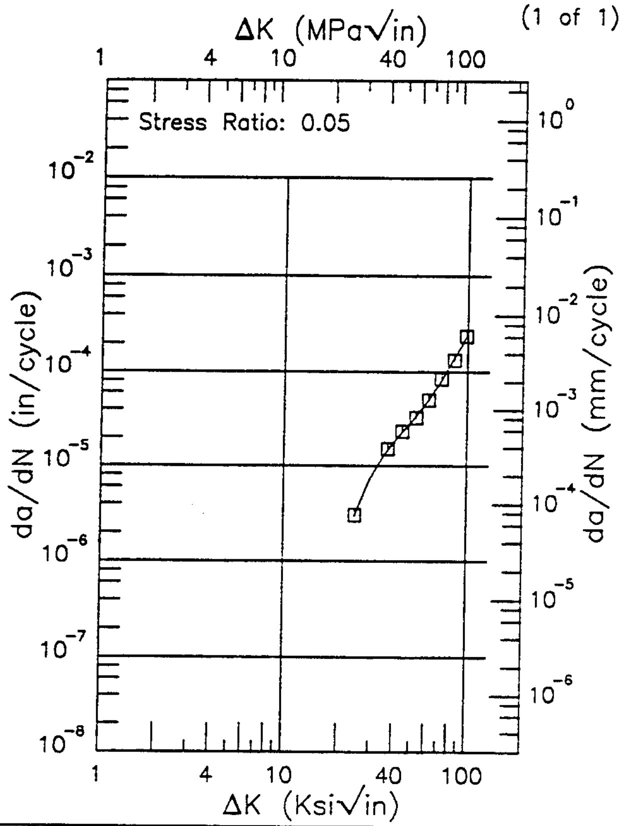
Figure 3.32.3.1.11

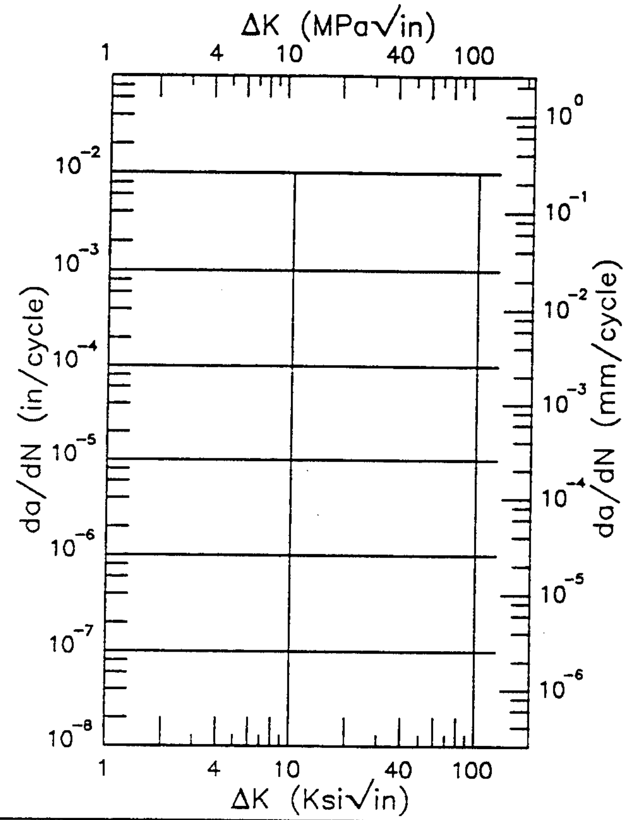
HP9–4–.20 R

Condition/Ht: 1525F 2HRS AC –100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: T–L
Frequency: 1 Hz
Environment: L.H.A.; RT

Yield Strength: 188 ksi
Ult. Strength: 204 ksi
Specimen Thk: 2 in.
Specimen Width: 5.81 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
24.44 (min)	2.98
25.	3.38
30.	7.74
35.	12.8
40.	18.2
50.	29.8
60.	46.4
70.	73.9
80.	117.
90.	176.
97.82 (max)	234.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
2.33	0. .5 .8 1.25 2.

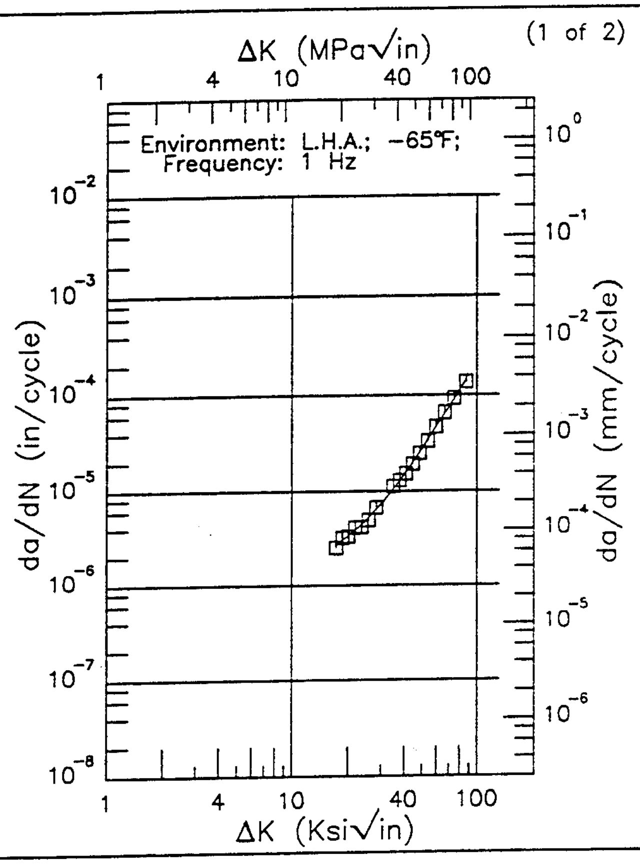
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.32.3.1.12

EF HP9-4-.20

Condition/Ht: 1525F 2HRS AC -100F 2HRS 1025F 4HRS
Form: 4 in. Billet
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.08

Yield Strength: 178 - 188 ksi
Ult. Strength: 204 - 209 ksi
Specimen Thk: 0.99 - 1 in.
Specimen Width: 6 in.
Ref: 88579

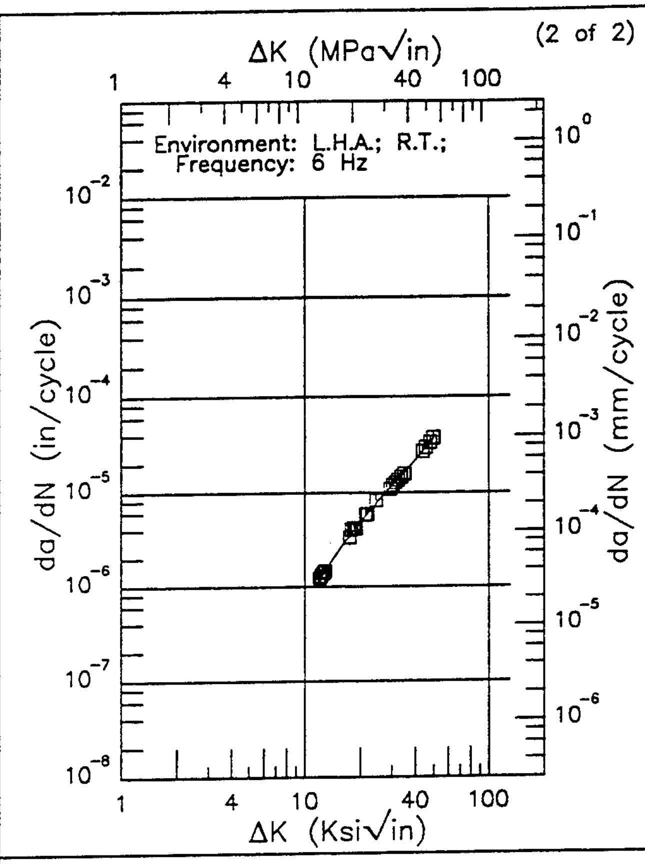


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.18 (min)	2.70
20.	3.32
25.	4.92
30.	7.29
35.	10.6
40.	15.0
50.	27.7
60.	47.0
70.	73.9
80.	110.
86.98 (max)	140.

RMS % Error 4.50

Life Prediction Ratio Summary

0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.94 (min)	1.15
13.	1.52
16.	2.77
20.	4.85
25.	8.01
30.	11.8
35.	16.4
40.	21.9
49.98 (max)	36.8

RMS % Error 3.76

Life Prediction Ratio Summary

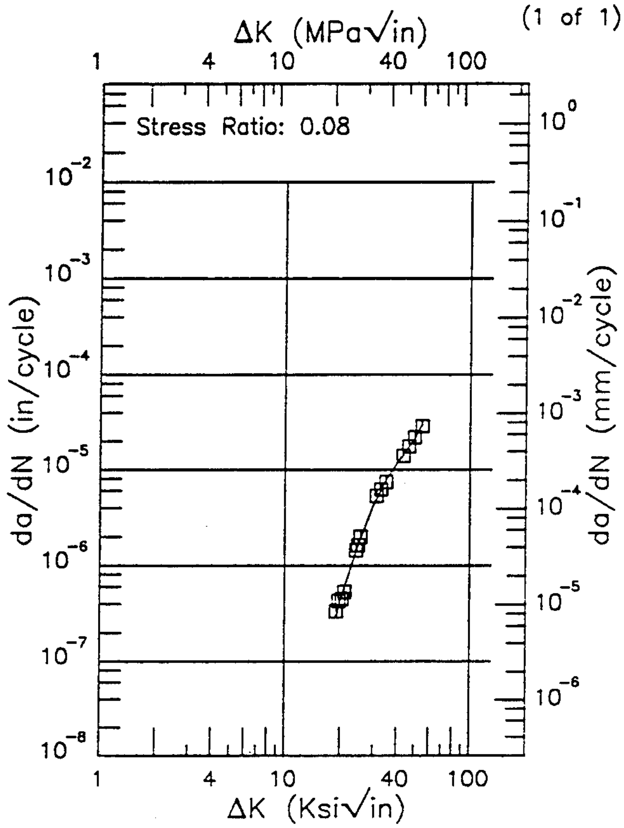
0. .5 .8 1.25 2.

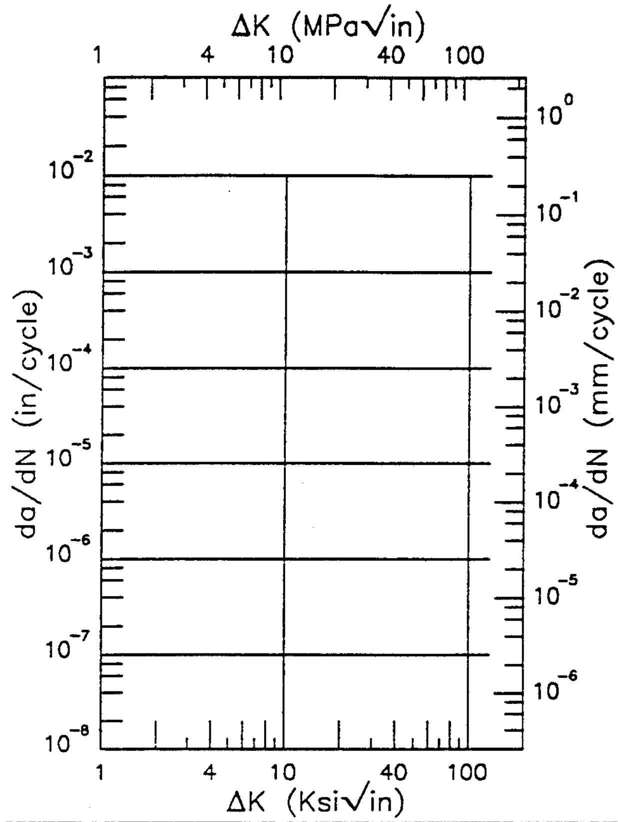
Figure 3.32.3.1.13

Condition/Ht: WELDED
Form: Weldment
Specimen Type: CT
Orientation: L-T
Frequency: 1 Hz
Environment: L.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.51 in.
Specimen Width: 6 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.87 (min)	0.290
20.	0.433
25.	1.72
30.	4.32
35.	7.92
40.	11.7
50.	21.3
54.51 (max)	29.4

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
7.23

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

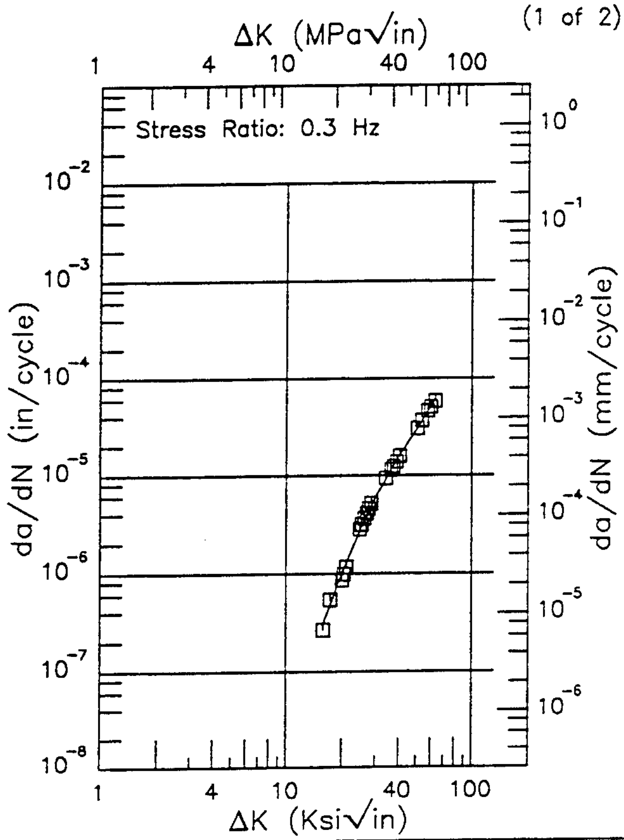
Figure 3.32.3.1.14

R HP9-4-.20

Condition/Ht: WELDED
Form: Weldment
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: L.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.49 - 0.5 in.
Specimen Width: 6.01 in.
Ref: 88579

(1 of 2)



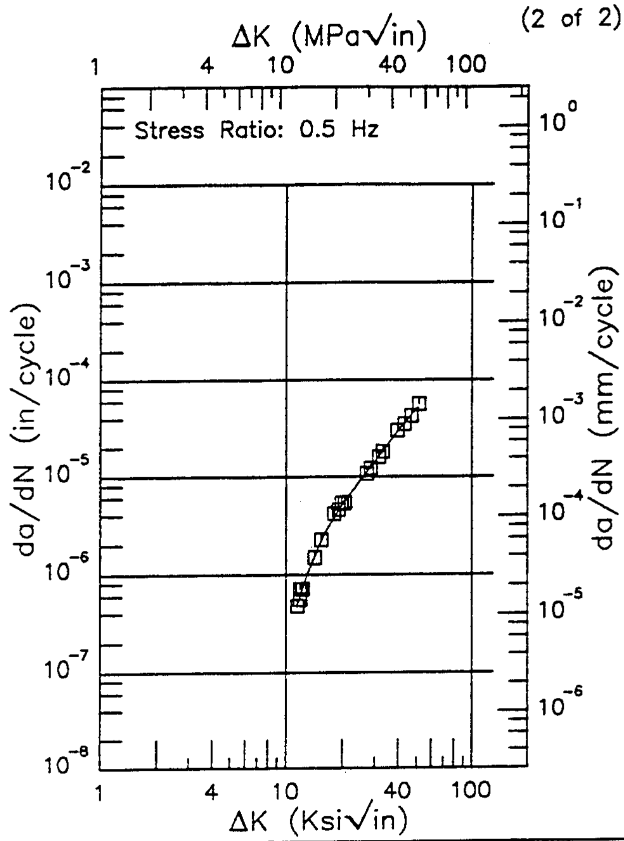
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.75 (min)	0.294
16.	0.321
20.	1.01
25.	2.81
30.	5.88
35.	10.2
40.	15.6
50.	29.5
60.	51.6
62.95 (max)	61.0

RMS % Error 7.25

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.48 (min)	0.476
13.	0.997
16.	2.56
20.	5.24
25.	9.11
30.	14.0
35.	21.0
40.	30.3
50.	50.6
51.28 (max)	52.8

RMS % Error 6.45

Life Prediction Ratio Summary

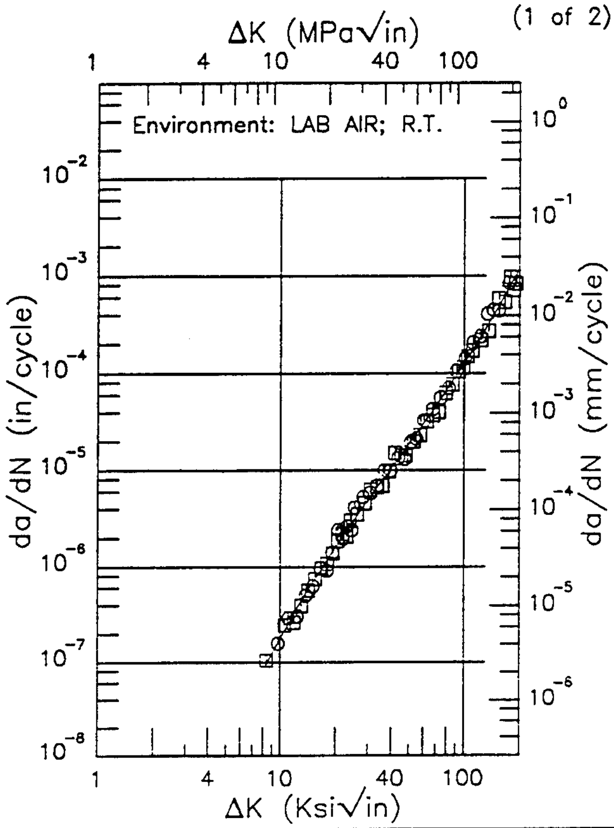
0. .5 .8 1.25 2.

Figure 3.32.3.1.15

Condition/Ht:
Form: 1.25 in. Forging
Specimen Type: WOL
Orientation: L-T
Stress Ratio: 0.02
Frequency: 0.1 - 20 Hz

Yield Strength: 196.5 ksi
Ult. Strength: 209.5 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: MA005

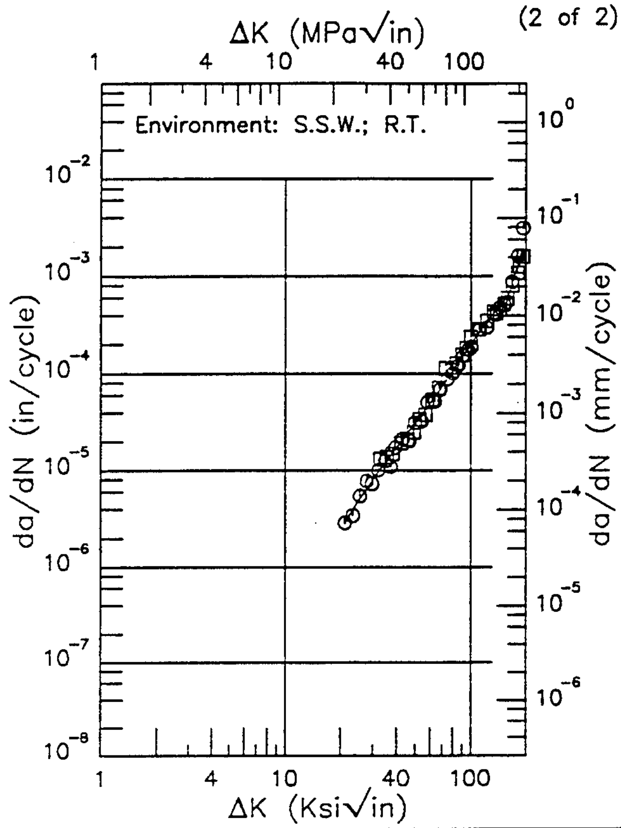
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.36 (min)	0.0939
9.	0.123
10.	0.180
13.	0.435
16.	0.833
20.	1.61
25.	3.01
30.	4.92
35.	7.41
40.	10.5
50.	18.9
60.	30.6
80.	66.8
100.	126.
130.	278.
160.	542.
192.57 (max)	1026.

RMS % Error	Life Prediction Ratio Summary
13.71	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
21.08 (min)	2.85
25.	4.80
30.	8.06
35.	12.2
40.	17.3
50.	30.7
60.	49.1
70.	74.0
80.	107.
90.	150.
100.	202.
130.	392.
160.	627.
192.73 (max)	1876.

RMS % Error	Life Prediction Ratio Summary
14.08	0. .5 .8 1.25 2.

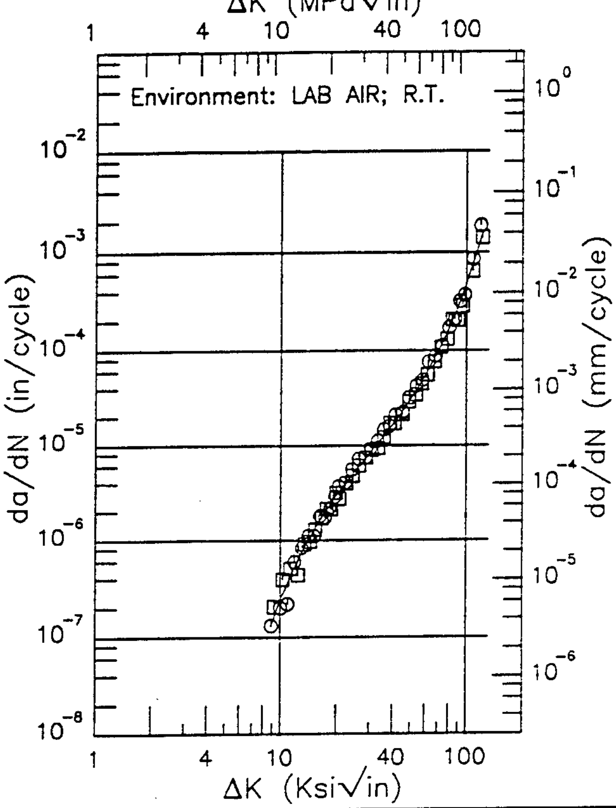
Figure 3.32.3.1.16

E

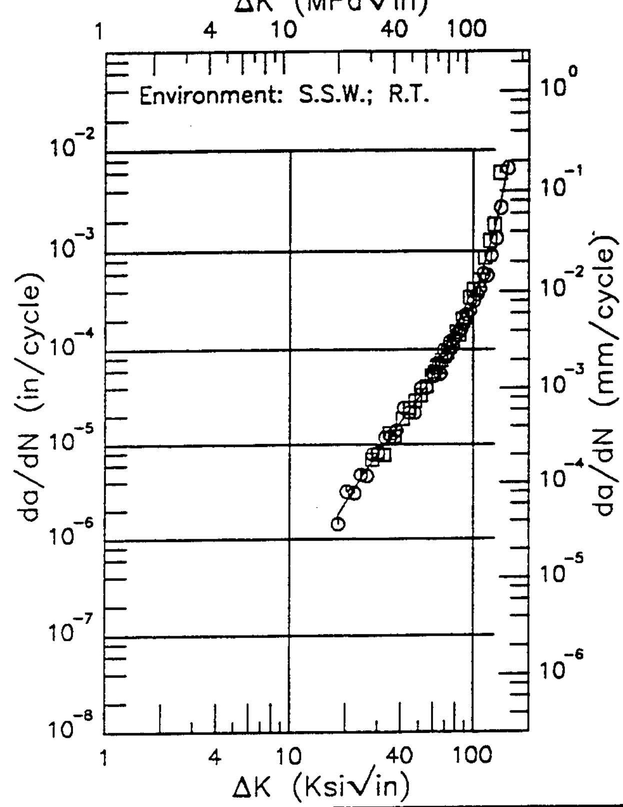
HP9-4-.20

Condition/Ht:	
Form: 1.25 in. Forging	Yield Strength: 198 ksi
Specimen Type: WOL	Ult. Strength: 212.5 ksi
Orientation: T-L	Specimen Thk: 1.25 in.
Stress Ratio: 0.02	Specimen Width: 5 in.
Frequency: 0.1 - 20 Hz	Ref: MA005

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.87 (min)	0.131
9.	0.141
10.	0.242
13.	0.751
16.	1.55
20.	2.99
25.	5.31
30.	8.25
35.	12.0
40.	16.7
50.	30.7
60.	54.5
70.	95.3
80.	165.
90.	285.
100.	490.
120.15 (max)	1437.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.18 (min)	1.76
20.	2.41
25.	4.74
30.	7.90
35.	12.0
40.	17.1
50.	31.4
60.	53.1
70.	85.9
80.	135.
90.	207.
100.	320.
130.	1507.
153.57 (max)	7206.

RMS % Error
14.19

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error
18.71

Life Prediction Ratio Summary

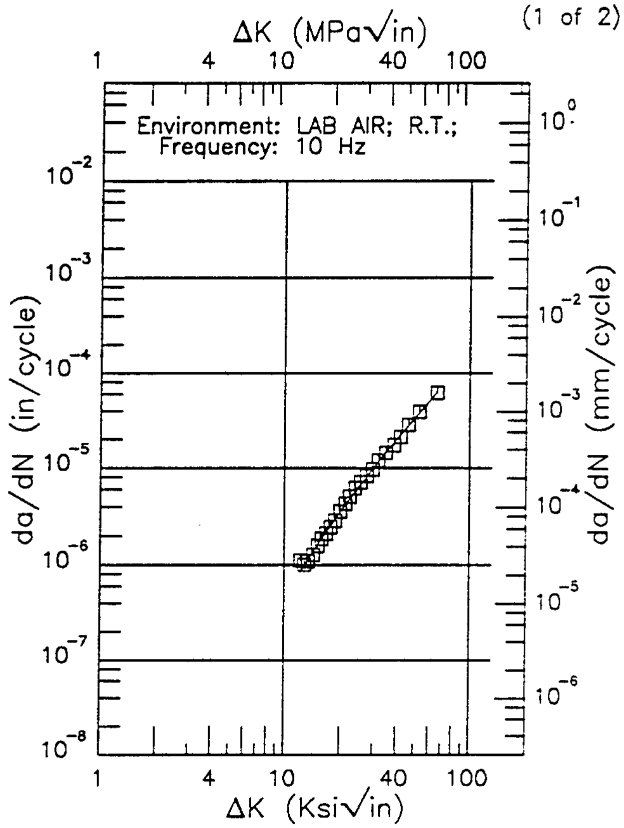
0. .5 .8 1.25 2.

Figure 3.32.3.1.17

Condition/Ht:
Form: 2.5 in. Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.02

Yield Strength: 185.5 ksi
Ult. Strength: 201 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: 88136

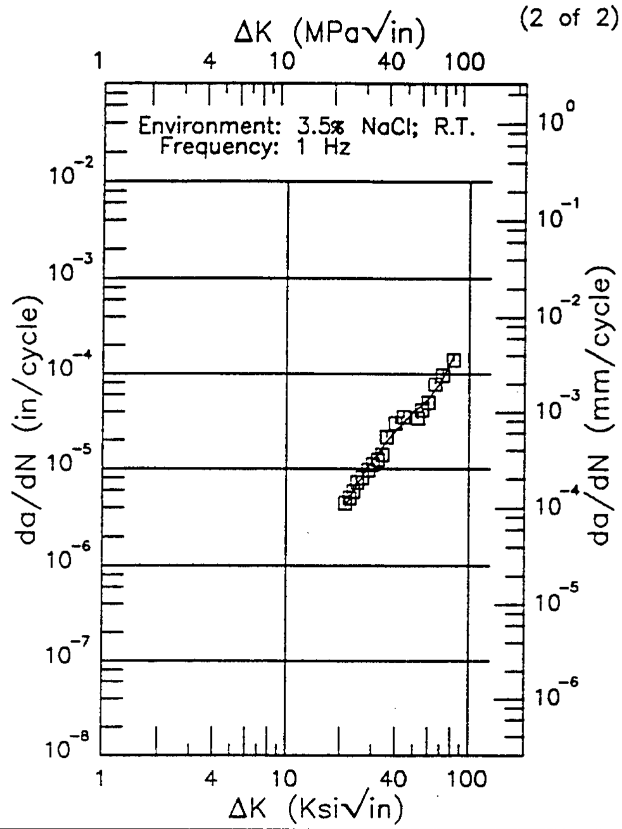
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.17 (min)	0.846
13.	1.04
16.	1.93
20.	3.58
25.	6.40
30.	10.1
35.	14.6
40.	19.9
50.	33.2
60.	50.0
66.04 (max)	62.1

RMS % Error	Life Prediction Ratio Summary
7.35	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
21.23 (min)	4.12
25.	7.04
30.	12.1
35.	18.1
40.	25.0
50.	39.6
60.	55.1
70.	80.3
80.	134.
81.85 (max)	150.

RMS % Error	Life Prediction Ratio Summary
11.86	0. .5 .8 1.25 2.

Figure 3.32.3.1.18

TABLE 3.32.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL HP9-4-.20

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
1525°F 2hrs OQ; -100°F 2hrs; 1025°F 4hrs	P	R.T.	L-T	189	S.T.W.	DCB	2	1	2.5	---	119	103	86280	1976	RI006
						DCB	2	1	2.5	---	119	105	86280	1976	RI006
						DCB	2	1	2.5	---	119	107	86280	1976	RI006
			T-L	190	S.T.W.	DCB	2	1	2.5	---	119	97	86280	1976	RI006
						DCB	2	1	2.5	---	119	93	86280	1976	RI006
						DCB	2	1	2.5	---	119	96	86280	1976	RI006
						DCB	2	1	2.5	---	119	97	86280	1976	RI006
						DCB	2	1	2.5	---	119	104	86280	1976	RI006
	FB	R.T.	L-T	186	S.C.S.	DCB	2	1	4	---	118	>129+	60180	1976	RI006
						DCB	2	1	4	---	118	>122+	60660	1976	RI006
					S.T.W.	DCB	2	1	4	---	118	<129+	86280	1976	RI006
						DCB	2	1	4	---	118	<126+	86280	1976	RI006
						DCB	2	1	4	---	118	110	86280	1976	RI006
			T-L	187	S.T.W.	DCB	2	1	4	---	118	109	86280	1976	RI006
						DCB	2	1	4	---	118	<117	86280	1976	RI006
						DCB	2	1	4	---	118	105	76860	1976	RI006
			S-T	---	S.T.W.	DCB	2	1	4	---	118	79+	86280	1976	RI006
						DCB	2	1	4	---	118	75+	116820	1976	RI006
						DCB	2	1	4	---	118	<97+	86280	1976	RI006
						DCB	2	1	4	---	118	81+	86280	1976	RI006

TABLE 3.32.3.3 (CONCLUDED)

K_{Iscc} SUMMARY FOR ALLOY STEEL HP9-4-.20

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
GTA Weld Weldment	P	R.T.	---	---	Synth Seawater	TDCB	---	---	0.5	---	---	65	---	1969	74232
Quenched and Tempered	P	R.T.	---	180	3.5% NaCl	CANT*	---	1	1	---	210	110	---	1972	83613
				195	3.5% NaCl	CANT*	---	1	1	---	200	110	---	1972	83613
Unspecified	P	R.T.	---	---	N_2O_4-0.2% H_2O	TDCB	5.5	0.5	0.5	---	150	140+	---	1971	80667
Unspecified	P	R.T.	---	---	Synth Seawater	TDCB	---	---	0.5	---	---	110+	---	1969	74232
Unspecified	F	R.T.	T-L	198	Sim. Sea Water	BWOL	3.083	1.247	1.25	1.37	---	92.8	195840	1977	MA005
						BWOL	3.088	1.25	1.25	1.37	---	94.5	195840	1977	MA005

+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.33.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20(CEVM) AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	FORGING	0.1	5-10				6.33	37.05	

TABLE 3.33.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20(CEVM) AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	FORGING	0.1	1-20				5.56	40.73	

TABLE 3.33.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.20(CEVM) AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	FORGING	0.1	1-10				5.78	43.6	

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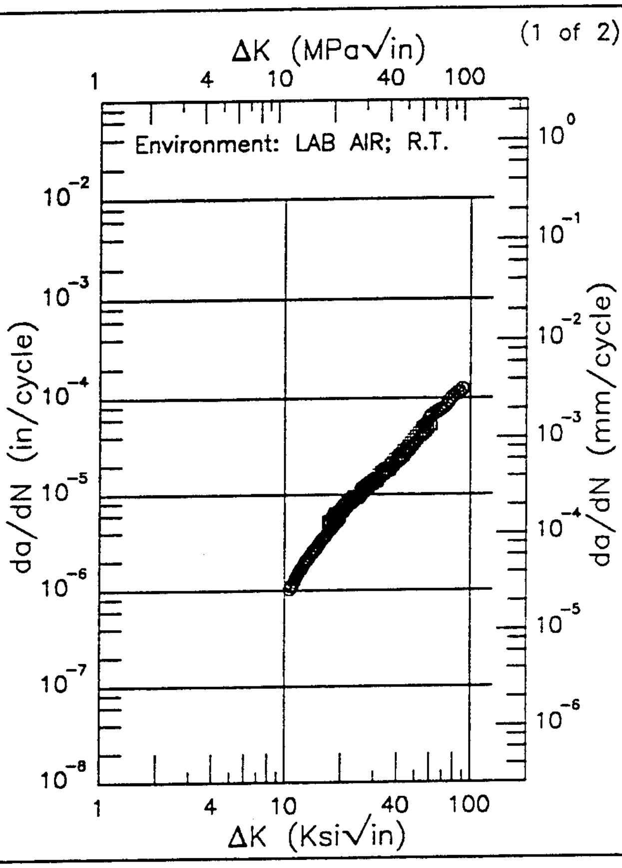
E

HP9-4-.20(CEVM)

Condition/Ht: ANNEALED	
Form: 3 in. Forging	Yield Strength: 191.8 ksi
Specimen Type: CT	Ult. Strength: 204.2 ksi
Orientation: L-T	Specimen Thk: 0.997 – 1.003 in.
Stress Ratio: 0.1	Specimen Width: 7.4 in.
Frequency: 1 – 20 Hz	Ref: NC002

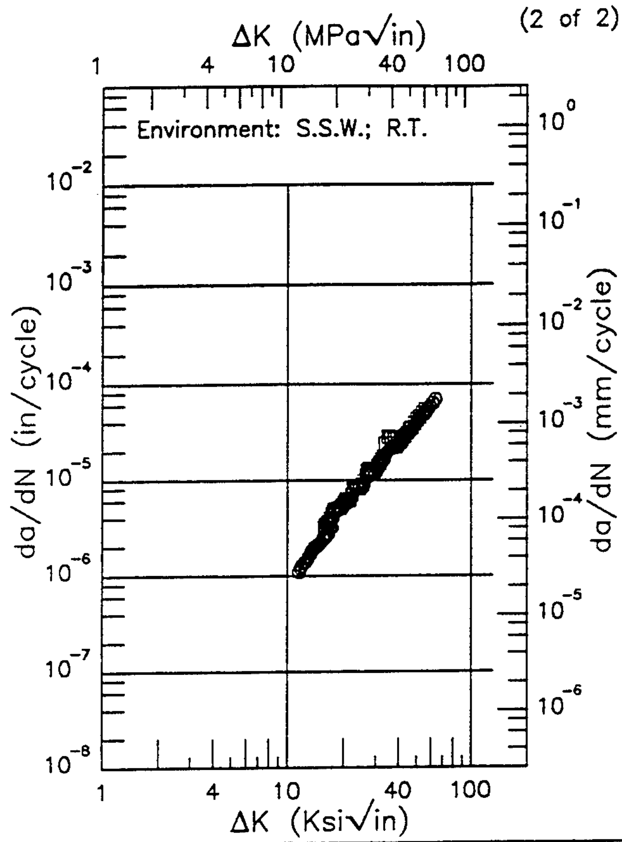
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.59 (min)	0.973
13.	2.04
16.	3.74
20.	6.33
25.	9.86
30.	13.7
35.	18.1
40.	23.2
50.	37.1
60.	57.1
70.	81.0
80.	103.
89.69 (max)	118.

RMS % Error	Life Prediction Ratio Summary
6.11	0. .5 .8 1.25 2.

(2 of 2)



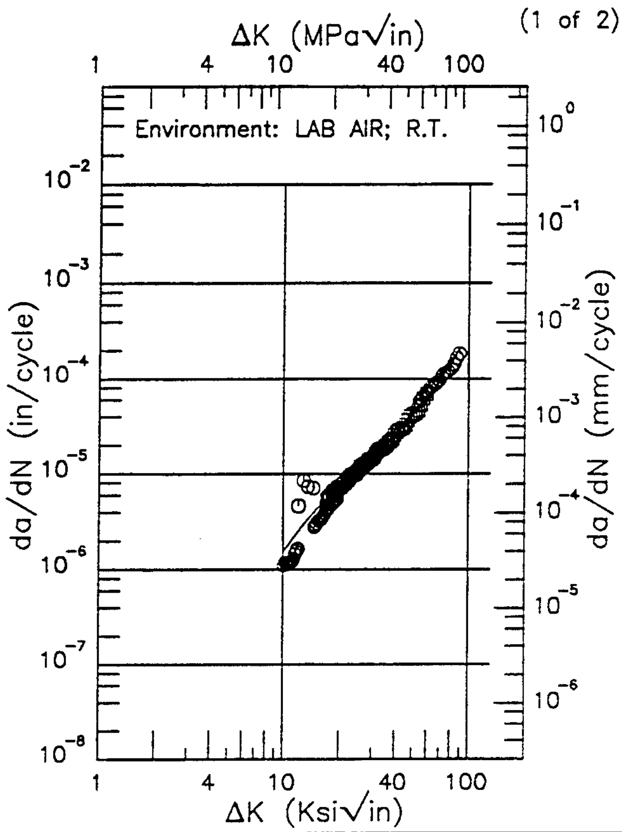
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.52 (min)	1.04
13.	1.59
16.	3.03
20.	5.56
25.	9.51
30.	14.2
35.	19.6
40.	25.8
50.	40.7
60.	59.8
63.26 (max)	67.1

RMS % Error	Life Prediction Ratio Summary
9.73	0. .5 .8 1.25 2.

Figure 3.33.3.1.1

Condition/Ht: ANNEALED	Yield Strength: 192.2 ksi
Form: 3 in. Forging	Ult. Strength: 204.8 ksi
Specimen Type: CT	Specimen Thk: 1.003 - 1.004 in.
Orientation: T-L	Specimen Width: 7.4 in.
Stress Ratio: 0.1	Ref: NC002
Frequency: 1 - 15 Hz	

(1 of 2)

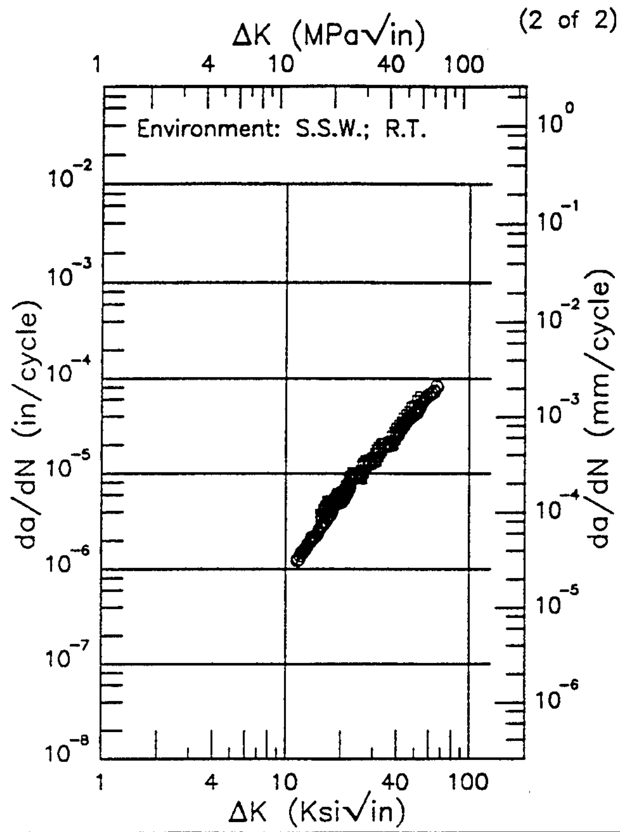


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.03 (min)	1.52
13.	3.08
16.	4.91
20.	7.57
25.	11.2
30.	15.3
35.	20.1
40.	25.7
50.	40.7
60.	62.9
70.	96.1
80.	146.
88.65 (max)	208.

RMS % Error: 29.57

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.55 (min)	1.16
13.	1.73
16.	3.22
20.	5.78
25.	9.77
30.	14.6
35.	20.2
40.	26.8
50.	43.6
60.	66.6
65.98 (max)	84.3

RMS % Error: 8.46

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 3.33.3.1.2

TABLE 3.34.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS
FOR ALLOY STEEL HP 9-4-.25 (VAR) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1550F 1HR OQ 1000F 2+2HR AC	---	---	---	98.9	4.5	2	---	---	---

TABLE 3.34.2.1

ALLOY STEEL HP 9-4-.25 (VAR) K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi • √in.)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
1550F 1 HR OQ 1000F 2+2 HR AC	Forging	3.00	-75	T-L	187.0	5.110	2.000	WOL-CT EQ.	1.834	1.08	123.00	115.0	11.3	1966	76411
		3.00			187.0	5.110	2.000	WOL-CT EQ.	1.864	0.82	107.00			1966	76411
1550F 1 HR OQ 1000F 2+2 HR AC	Forging	3.00	-40	T-L	188.0	5.110	2.000	WOL-CT EQ.	1.886	0.86	110.00	111.0	1.4	1966	76411
		3.00			188.0	5.110	2.000	WOL-CT EQ.	1.863	0.89	112.00			1966	76411
1550F 1 HR OQ 1000F 2+2 HR AC	Forging	3.00	0	T-L	187.0	5.110	2.000	WOL-CT EQ.	1.837	0.82	107.00	106.0	1.4	1966	76411
		3.00			187.0	5.110	2.000	WOL-CT EQ.	1.879	0.79	105.00			1966	76411
1550F 1 HR OQ 1000F 2+2 HR AC	Forging	3.00	32	T-L	187.0	5.110	2.000	WOL-CT EQ.	1.868	0.79	104.00	101.7	3.3	1966	76411
		3.00			187.0	5.110	2.000	WOL-CT EQ.	1.954	0.71	99.40			1966	76411
1550F 1 HR OQ 1000F 2+2 HR AC	Forging	3.00	R.T.	T-L	175.0	5.110	2.000	WOL-CT EQ.	1.822	0.75	95.70	98.8	4.5	1966	76411
		3.00			175.0	5.110	2.000	WOL-CT EQ.	1.808	0.85	102.00			1966	76411
1550F 1 HR OQ 1000F 2+2 HR AC	Forging	3.00	100	T-L	180.0	5.110	2.000	WOL-CT EQ.	1.853	0.84	104.00	102.5	2.1	1966	76411
		3.00			180.0	5.110	2.000	WOL-CT EQ.	1.855	0.78	101.00			1966	76411
1550F 1 HR OQ 1000F 2+2 HR AC	Forging	3.00	150	T-L	175.0	5.110	2.000	WOL-CT EQ.	1.834	1.00	111.00	108.5	3.5	1966	76411
		3.00			175.0	5.110	2.000	WOL-CT EQ.	1.824	0.92	106.00			1966	76411

TABLE 3.35.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL HP 9-4-.30 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Plate	HEAT TREATED TO 49 RC HARDNESS	---	---	---	82.5	5.	2	---	---	---
Forging	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1000F 4HR	106	1.4	2	89	3	3	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1025F 4HR	---	---	---	93.5	0.7	2	---	---	---
	1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1050F 4HR	---	---	---	87.6	0.8	2	---	---	---
	1650F 2HR AC 1550F 2HR OQ 1000F 2+2HR AC	82	0	2	---	---	---	---	---	---

TABLE 3.35.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
UTS=220-240KSI	BILLET	-1	0.1				3.01	35.89	
		0.	0.1				6.12	36.06	260.58
99	BAR	0.02	1					42.78	

TABLE 3.35.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: L-T

ENVIRONMENT: Alt Immersion Seawater - Immersion

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=220-240KSI	BILLET	0.	1				1.62	29.68	
		0.	10				3.17		

TABLE 3.35.1.2.3

**FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
HP9-4-.30 AT ROOM TEMPERATURE**

ORIENTATION:
L-T

ENVIRONMENT:
Alt Immersion Seawater - 1st Half Dry Cycle

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=220-240KSI	BILLET	0.	1				2.7	25.83	
		0.	10				3.19		

TABLE 3.35.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: L-T

ENVIRONMENT: Alt Immersion Seawater - 2nd Half Dry Cycle

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UTS=220-240KSI	BILLET	0.	1				4.51	33.2	
		0.	10				3.43	28.67	

TABLE 3.35.1.2.5

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi*$\sqrt{in}$)					
		*		2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS OQ -100F 2HRS 1025F 2+2HR	FORGED BAR	0.3	6				4.43	90.08	
1550F 2HRS OQ -100F 1HR 1025F 2+2HR	FORGED BAR	0.08	1			0.89	5.04		
		0.3	6			1.12	7.35		
		0.5	6			1.17	6.6		
UTS=220-240KSI	BILLET	-1	10				3.59	29.11	
		0.	10				3.37	25.64	136.37
		0.5	10			0.89	6.73	47.35	

TABLE 3.35.1.2.6

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				Δ*K Level (Ksi√in)*					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	5-20			0.41	2.97	37.38	
	BAR	0.02	1					46.37	
		0.02	10				3.59	46.57	

TABLE 3.35.1.2.7

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-15					37.72	298.27

TABLE 3.35.1.2.8

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
1525F 2HRS OQ -100F 2HRS 1025F 2+2HR	FORGED BAR	0.08	1				5.68	62.33	
1550F 2HRS OQ -100F 1HR 1025F 2+2HR	FORGED BAR	0.08	0.1			2.63	13.42		
		0.3	1			0.89	7.34		
		0.5	1			1.8	9.22		

TABLE 3.35.1.2.9

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.	15				3.02		
		0.1	0.1					114.04	
		0.1	0.1					114.04	
		0.1	0.1					114.04	
		0.1	1					56.54	
		0.1	1					56.54	
		0.1	1					56.54	
		0.5	0.1				18.68		
		0.5	0.1				18.68		
		0.5	0.1				18.68		
		0.5	1				11.3		
		0.5	1				11.3		
		0.5	1				11.3		
		0.8	0.1			71.25	292.97		

TABLE 3.35.1.2.10

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L

ENVIRONMENT: Alt JP-4 Jet Fuel & Distilled Water

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.1	1					60.06	

TABLE 3.35.1.2.11

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.	15				2.78		
		0.1	0.1					316.2	
		0.1	1					51.71	
		0.1	1					51.33	
		0.5	1				23.98		
		0.5	1				23.98		

TABLE 3.35.1.2.12

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Dry Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.5	0.1				7.03		
		0.8	1			14.93			

TABLE 3.35.1.2.13

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: L.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1550F 2HRS OQ -100F 1HR 1025F 2+2HR	FORGED BAR	0.08	6				5.13		
1550F 2HRS OQ -100F 3HRS 1000F 2+2HRS	FORGED BAR	0.08	6				3.46	46.38	

TABLE 3.35.1.2.14

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-20			0.46	3.14	49.14	1733.09

TABLE 3.35.1.2.15

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				Δ*K Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	FORGING	0.02	0.1-15				2.44	44.09	2260.23

TABLE 3.35.1.2.16

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
1550F 2HRS OQ -100F 1HR 1025F 2+2HR	FORGED BAR	0.08	1			0.69	4.84		
UNSPECIFIED	PLATE	0.1	0.1					173.09	
		0.1	0.1					173.09	
		0.1	0.1					173.09	
		0.1	1					68.83	
		0.1	1					68.83	
		0.5	1				9.12		
		0.5	1				9.12		

TABLE 3.35.1.2.17

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HP9-4-.30 AT ROOM TEMPERATURE

ORIENTATION: T-L

ENVIRONMENT: Water Saturated JP-4 Jet Fuel

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	PLATE	0.	15				2.54		
		0.1	0.1					63.97	
		0.1	0.1					63.97	
		0.1	0.1					63.97	
		0.1	1					51.66	
		0.1	1					49.21	
		0.1	1					51.66	
		0.5	0.1				8.46		
		0.5	0.1				8.46		
		0.5	0.1				8.46		
		0.5	1				7.29		
		0.5	1				7.29		
		0.5	1				7.29		

TABLE 3.35.2.1

ALLOY STEEL HP 9-4-.30 K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi • √in.)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
---	Forging	1.25	81	L-T	207.5	2.529	1.245	CT	1.273	0.65	106.10	107.1	1.5	1977	MA005
		1.25			207.5	2.519	1.245	CT	1.263	0.67	108.19			1977	MA005
---	Forging	1.25	81	T-L	208.3	2.523	1.246	CT	1.258	0.58	101.10	101.1	0.0	1977	MA005
		1.25			208.3	2.534	1.246	CT	1.293	0.58	101.10			1977	MA005
1525F OQ -100F 3 HR 1050F 4HR	Forging	3.00	-65	T-L	175.0	5.000	1.900	CT	---	1.64	142.00	---	---	1974	90011
1650F 2HR AC 1550F 2HR OQ 1000F 2+2HR AC	Forging	3.25	R.T.	L-T	192.0	4.003	2.015	CT	1.933	0.48	82.00	82.0	0.0	1974	88136
		3.25			192.0	4.014	2.016	CT	1.997	0.48	82.00			1974	88136
1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1000F 4HR	Forging	3.00	-65	L-T	220.0	3.000	1.000	CT	---	0.23	67.00	66.5	0.7	1974	90011
		3.00			220.0	3.000	1.000	CT	---	0.22	66.00			1974	90011
1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1000F 4HR	Forging	3.00	R.T.	L-T	206.0	3.000	1.000	CT	---	0.67	107.00	106.0	1.4	1974	90011
		3.00			206.0	3.000	1.000	CT	---	0.65	105.00			1974	90011
1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1000F 4HR	Forging	3.00	R.T.	T-L	206.0	3.000	1.000	CT	---	0.43	86.00	89.0	3.0	1974	90011
		3.00			215.0	3.000	1.000	CT	---	0.46	92.00			1974	90011
		3.00			215.0	3.000	1.000	CT	---	0.43	89.00			1974	90011
1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1025F 4HR	Forging	3.00	R.T.	L-T	205.0	3.000	1.000	CT	---	0.80	116.00	---	---	1974	90011
1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1025F 4HR	Forging	3.00	R.T.	T-L	205.0	3.000	1.000	CT	---	0.52	94.00	93.5	0.7	1974	90011
		3.00			205.0	3.000	1.000	CT	---	0.51	93.00			1974	90011

TABLE 3.35.2.1 (CONCLUDED)

ALLOY STEEL HP 9-4-.30 K_{Ic}

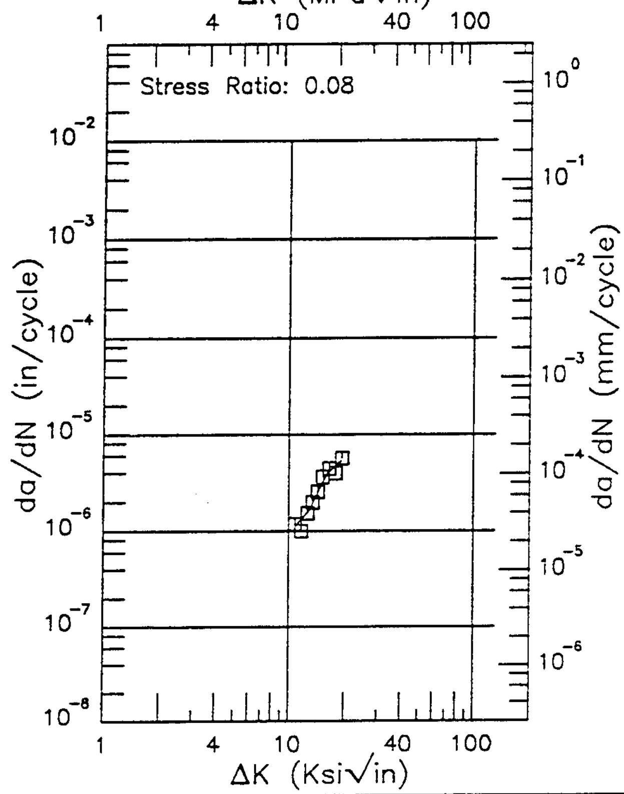
CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1650F 1-2HR AC 1525F 1-2HR OQ -100F 1-3HR 1050F 4HR	Forging	3.00	R.T.	T-L	200.0	3.000	1.000	CT	---	0.48	88.10	87.6	0.8	1974	90011
		3.00			200.0	3.000	1.000	CT	---	0.47	87.00			1972	84306
1650F 2HRS AC 1550F 2HR OQ -100F 2HR AC 1000F 4HR AC 1000F 4HR AC	Forging	---	R.T.	---	201.8	2.008	0.997	CT	1.024	0.80	114.20	---	---	1977	AM002
1650F AC 1525F 1-2HR OQ -100F 1-3HR 1050F 4HR	Forging	3.00	R.T.	T-L	197.0	3.000	1.000	CT	---	0.67	102.00	---	---	1974	90011
HEAT TREATED TO 49 RC HARDNESS	Plate	3.25	R.T.	T-L	189.0	2.006	1.005	NB	1.010	0.44	78.90	82.5	5.0	1971	84029
		3.25			189.0	2.004	1.005	NB	0.990	0.52	86.00			1971	84029

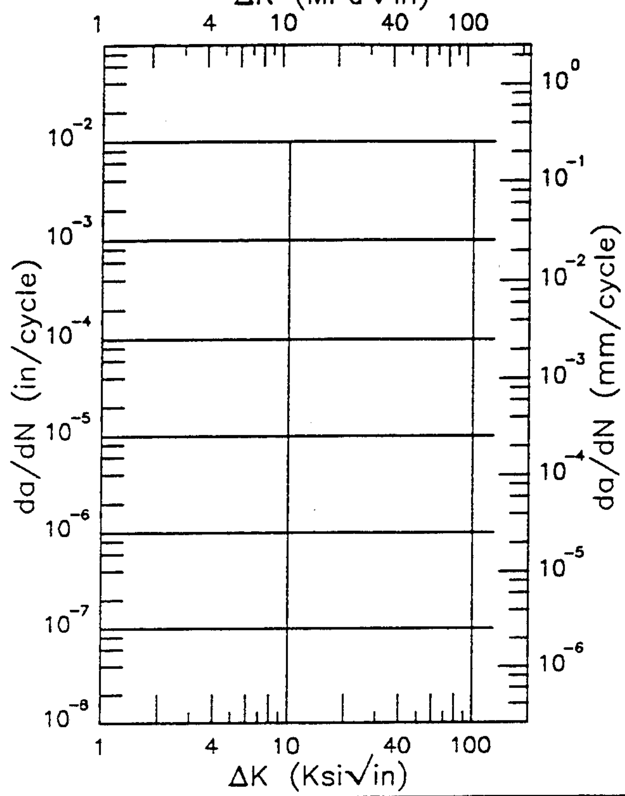
R HP9-4-.30

Condition/Ht: 1525F 2HRS OQ -100F 1HR 1025F 2+2HR
Form: 3 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 1 Hz
Environment: L.H.A.; RT

Yield Strength: 216 ksi
Ult. Strength: 239 ksi
Specimen Thk: 1 in.
Specimen Width: 5.01 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
10.79 (min)	1.13
13.	1.65
16.	3.89
19.15 (max)	5.32

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error 11.67

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.35.3.1.1

Condition/Ht: 1525F 2HRS OQ -100F 2HRS 1025F 2+2HR

Form: 3 in. Forged Bar

Specimen Type: CT

Orientation: L-T

Stress Ratio: 0.08 - 0.3

Yield Strength: 216 ksi

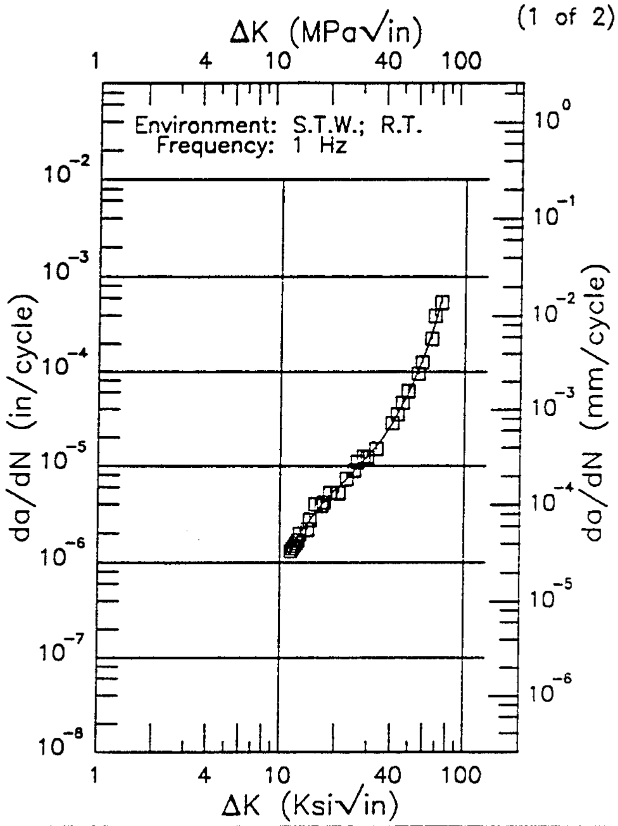
Ult. Strength: 239 - 239.6 ksi

Specimen Thk: 0.97 in.

Specimen Width: 4.97 in.

Ref: 88579

(1 of 2)



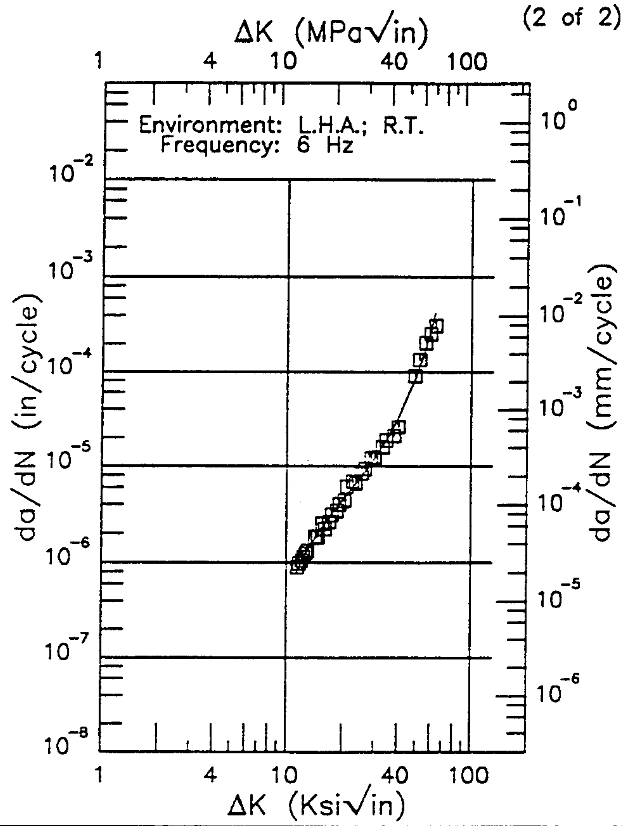
ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
11.35 (min)	1.25
13.	1.98
16.	3.50
20.	5.68
25.	8.78
30.	12.8
35.	18.6
40.	27.4
50.	62.3
60.	152.
70.	388.
73.59 (max)	550.

RMS % Error 8.23

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
11.36 (min)	0.808
13.	1.35
16.	2.53
20.	4.43
25.	7.49
30.	12.0
35.	19.3
40.	31.6
50.	90.1
60.	278.
63.58 (max)	422.

RMS % Error 10.87

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.35.3.1.2

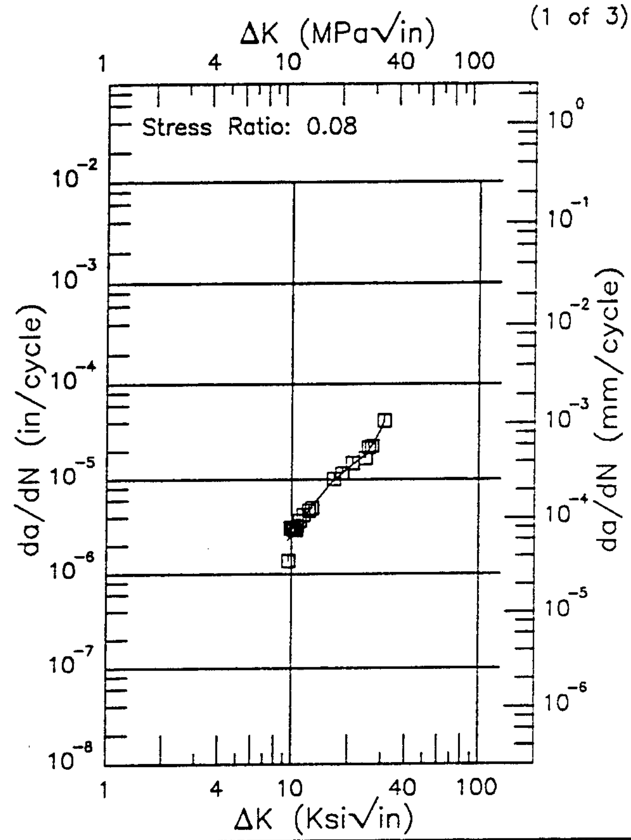
HP9-4-.30

R

Condition/Ht: 1550F 2HRS OQ -100F 1HR 1025F 2+2HR
Form: 3 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 0.1 - 1 Hz
Environment: S.T.W.; RT

Yield Strength: 198 ksi
Ult. Strength: 220 ksi
Specimen Thk: 0.74 - 0.991 in.
Specimen Width: 7.39 - 7.4 in.
Ref: 88579;85837

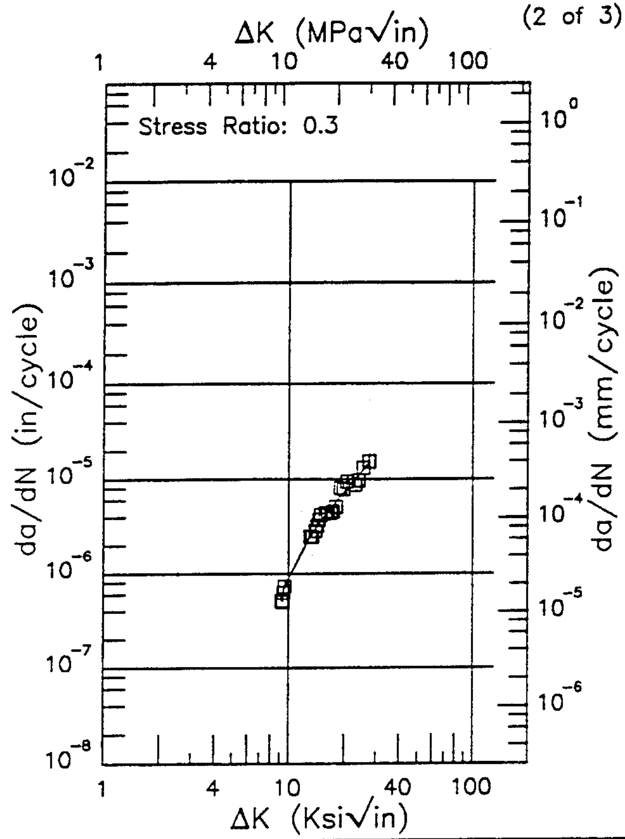
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.52 (min)	2.28
10.	2.63
13.	5.43
16.	8.93
20.	13.4
25.	18.8
30.	35.2
30.92 (max)	41.5

RMS % Error	Life Prediction Ratio Summary
13.30	0. .5 .8 1.25 2.

(2 of 3)



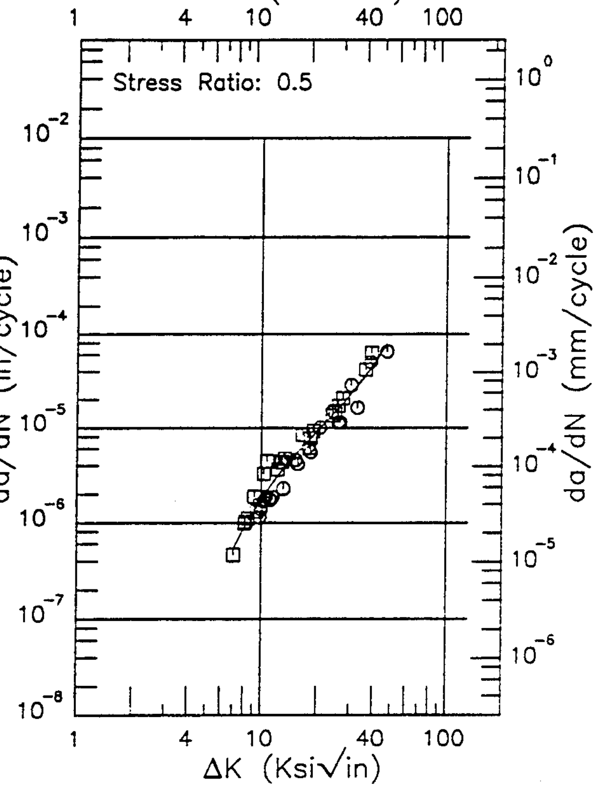
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.12 (min)	0.568
10.	0.890
13.	2.44
16.	4.38
20.	7.34
25.	12.0
27.24 (max)	14.6

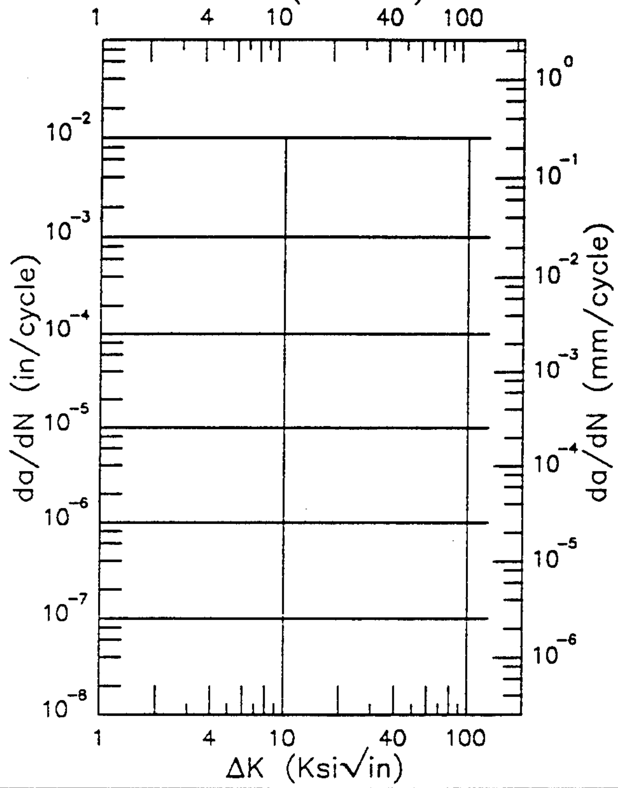
RMS % Error	Life Prediction Ratio Summary
11.10	0. .5 .8 1.25 2.

Figure 3.35.3.1.3

Condition/Ht: 1550F 2HRS OQ −100F 1HR 1025F 2+2HR
Form: 3 in. Forged Bar
Specimen Type: CT
Orientation: L−T
Frequency: 0.1 − 1 Hz
Environment: S.T.W.; RT
Yield Strength: 198 ksi
Ult. Strength: 220 ksi
Specimen Thk: 0.74 − 0.991 in.
Specimen Width: 7.39 − 7.4 in.
Ref: 88579;85837

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.06 (min)	0.546
8.	0.874
9.	1.30
10.	1.80
13.	3.59
16.	5.76
20.	9.22
25.	14.7
30.	22.2
35.	32.5
40.	47.0
47.24 (max)	79.0

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
28.95	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

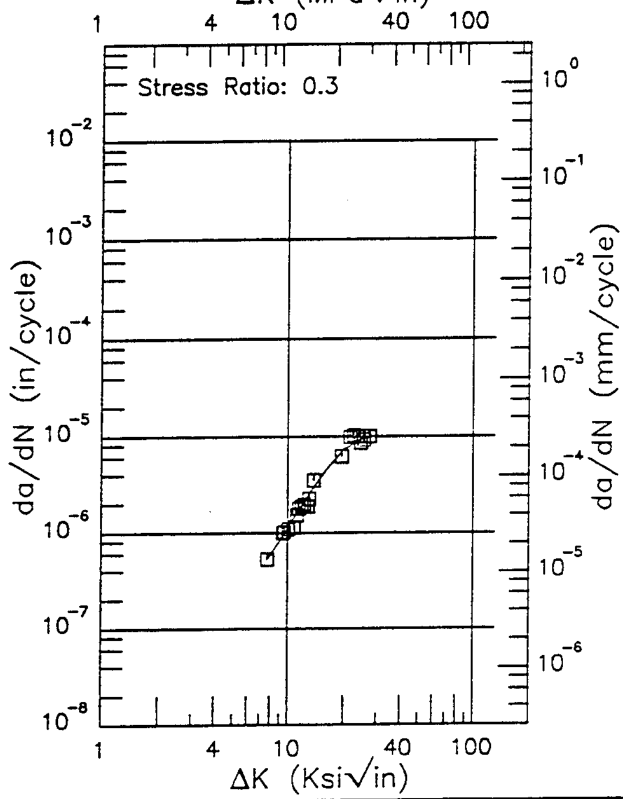
Figure 3.35.3.1.3 (Concluded)

R HP9-4-.30

Condition/Ht: 1550F 2HRS OQ -100F 1HR 1025F 2+2HR
Form: 3 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: L.H.A.; RT

Yield Strength: 198 ksi
Ult. Strength: 220 ksi
Specimen Thk: 0.988 - 0.993 in.
Specimen Width: 7.4 in.
Ref: 85837

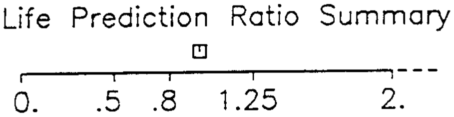
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.73 (min)	0.529
8.	0.581
9.	0.816
10.	1.12
13.	2.52
16.	4.51
20.	7.35
25.	9.57
27.36 (max)	9.82

RMS % Error 12.13

Life Prediction Ratio Summary



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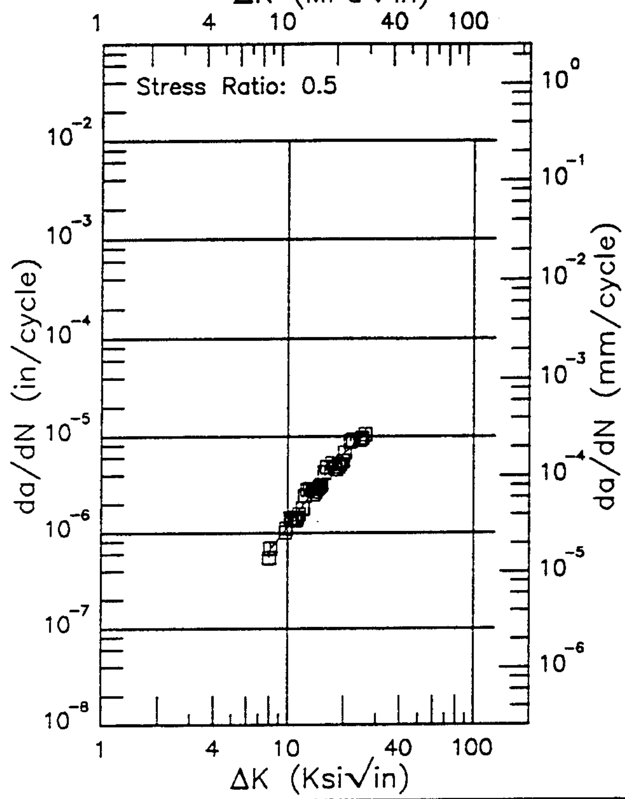


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.94 (min)	0.632
8.	0.645
9.	0.880
10.	1.17
13.	2.36
16.	3.99
20.	6.60
25.	9.91
25.94 (max)	10.5

RMS % Error 11.04

Life Prediction Ratio Summary

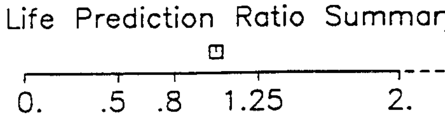


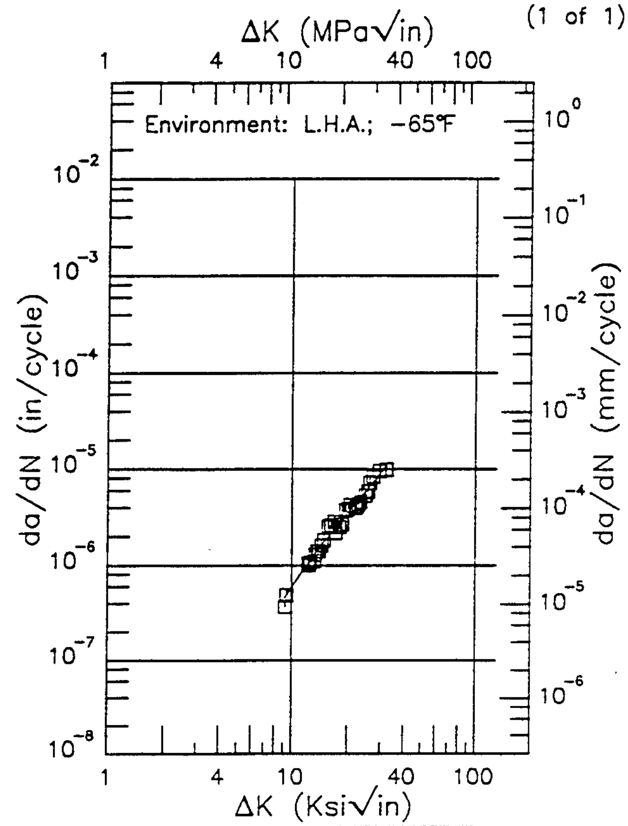
Figure 3.35.3.1.4

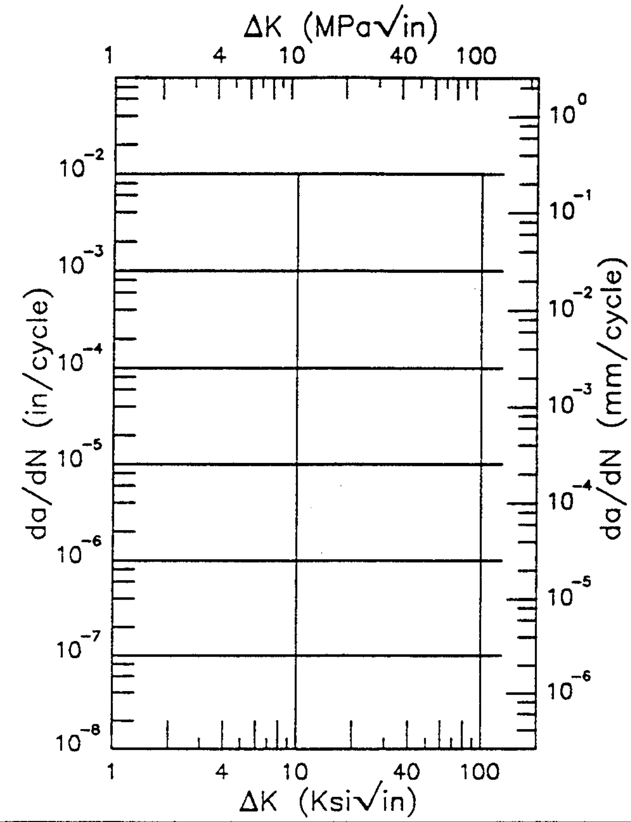
Condition/Ht: 1550F 2HRS OQ -100F 1HR 1025F 2+2HR

Form: 3 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 6 Hz

Yield Strength: 198 ksi
Ult. Strength: 220 ksi
Specimen Thk: 0.992 in.
Specimen Width: 7.4 in.
Ref: 85837

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.19 (min)	0.454
10.	0.590
13.	1.24
16.	2.10
20.	3.58
25.	6.01
30.	9.24
31.92 (max)	10.7

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
11.33	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

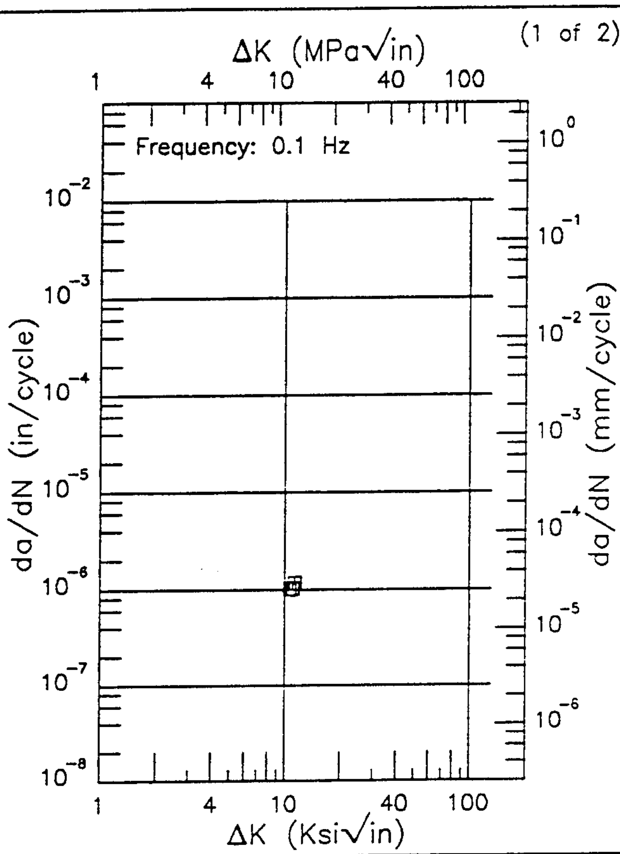
Figure 3.35.3.1.5

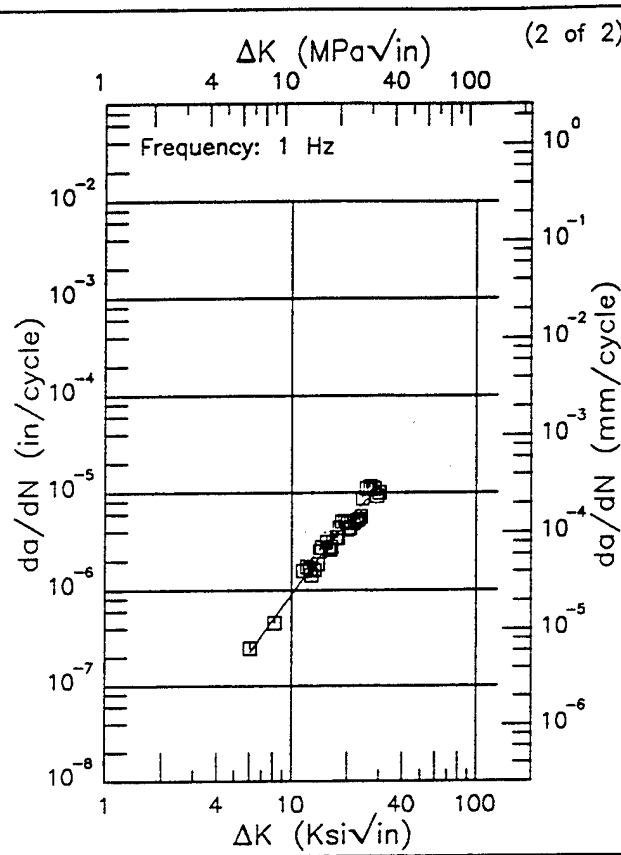
F

HP9-4-.30

Condition/Ht: 1550F 2HRS OQ -100F 1HR 1025F 2+2HR
Form: 3 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Environment: L.H.A.; RT

Yield Strength: 198 ksi
Ult. Strength: 220 ksi
Specimen Thk: 0.992 - 1 in.
Specimen Width: 7.4 in.
Ref: 88579;85837





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.05 (min)	0.226
7.	0.336
8.	0.485
9.	0.669
10.	0.890
13.	1.78
16.	3.00
20.	5.04
25.	8.05
29.80 (max)	11.1

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

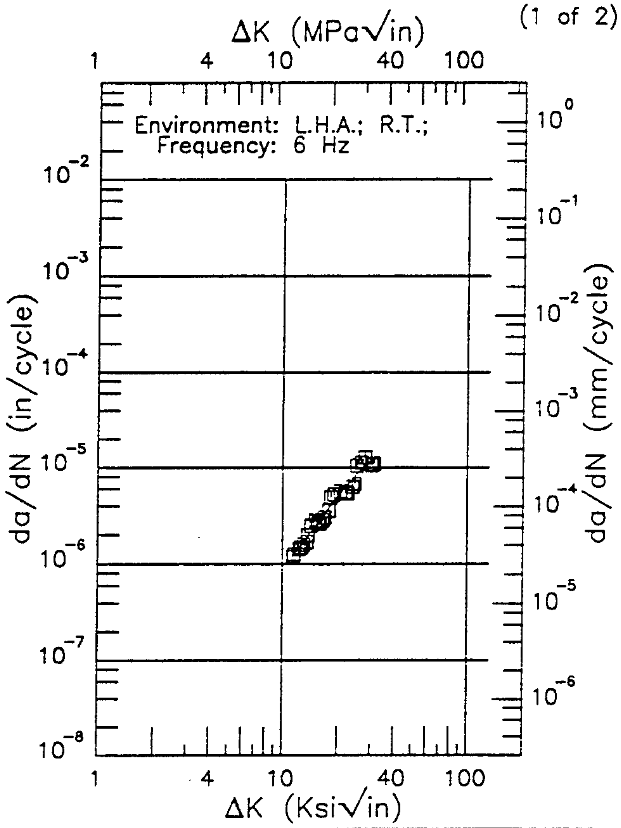
RMS % Error	Life Prediction Ratio Summary
15.86	0. .5 .8 1.25 2.

Figure 3.35.3.1.6

Condition/Ht: 1550F 2HRS OQ -100F 1HR 1025F 2+2HR
Form: 3 in. Forged Bar
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.08

Yield Strength: 198 - 199 ksi
Ult. Strength: 220 - 223 ksi
Specimen Thk: 0.74 - 0.986 in.
Specimen Width: 6 - 7.4 in.
Ref: 85837;88579

(1 of 2)

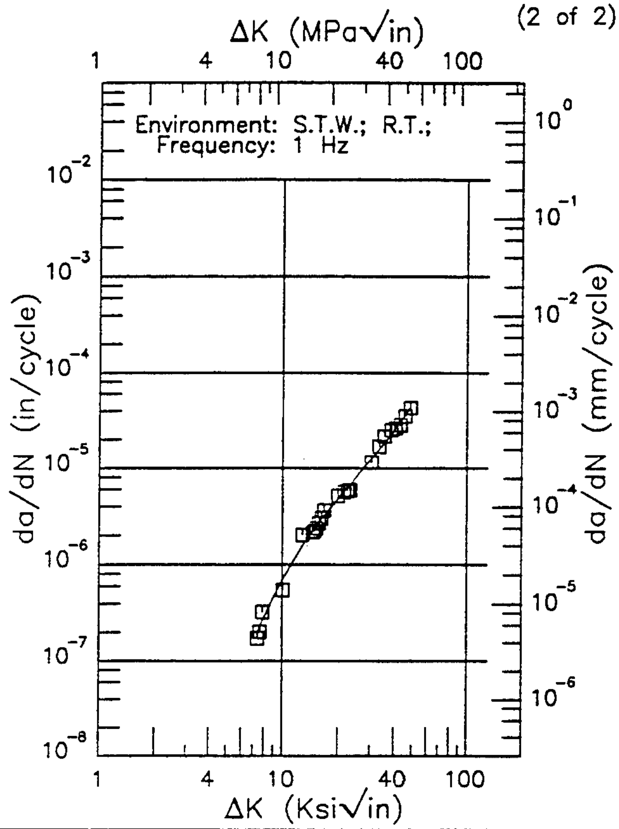


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.36 (min)	1.18
13.	1.67
16.	2.89
20.	5.13
25.	8.51
30.	11.9
31.16 (max)	12.6

RMS % Error: 12.33

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.33 (min)	0.196
8.	0.289
9.	0.466
10.	0.688
13.	1.60
16.	2.81
20.	4.84
25.	8.07
30.	12.2
35.	17.7
40.	24.9
48.54 (max)	42.8

RMS % Error: 12.09

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 3.35.3.1.7

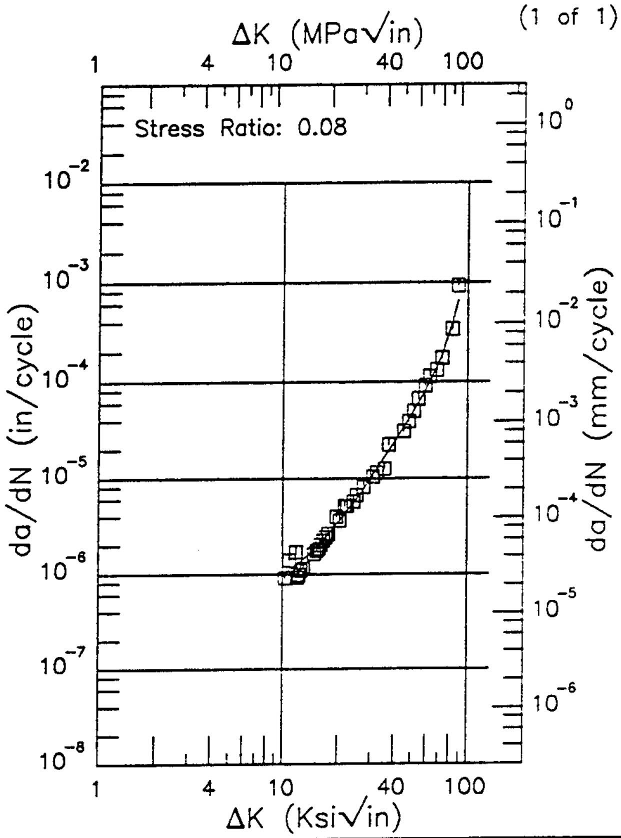
HP9-4-.30

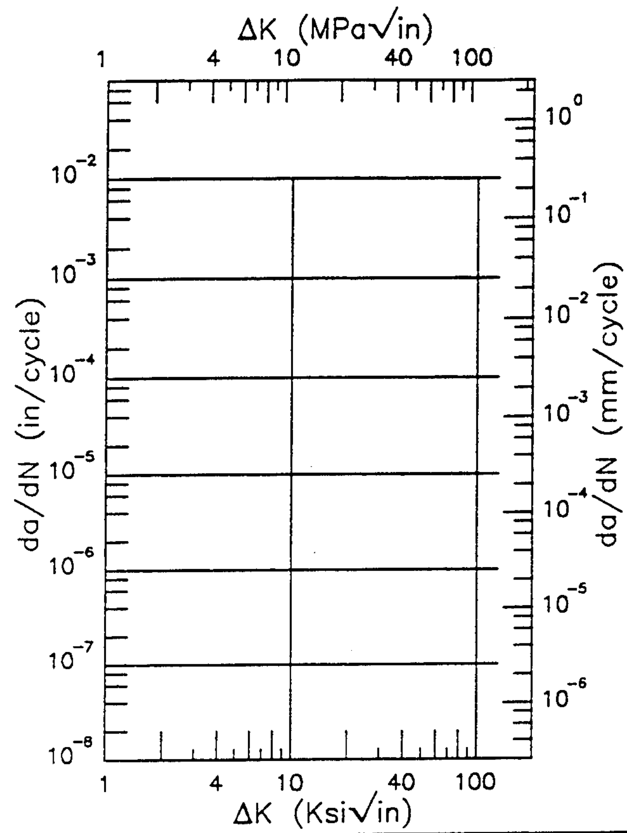
R

Condition/Ht: 1550F 2HRS OQ -100F 3HRS 1000F 2+2HRS

Form: 3 in. Forged Bar	Yield Strength: 215 ksi
Specimen Type: CT	Ult. Strength: 244 ksi
Orientation: T-L	Specimen Thk: 0.97 in.
Frequency: 6 Hz	Specimen Width: 4.98 in.
Environment: L.H.A.; RT	Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.28 (min)	1.03
13.	1.42
16.	2.09
20.	3.46
25.	6.14
30.	10.2
35.	16.0
40.	23.7
50.	46.4
60.	82.9
70.	156.
80.	325.
88.40 (max)	663.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
16.18	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.35.3.1.8

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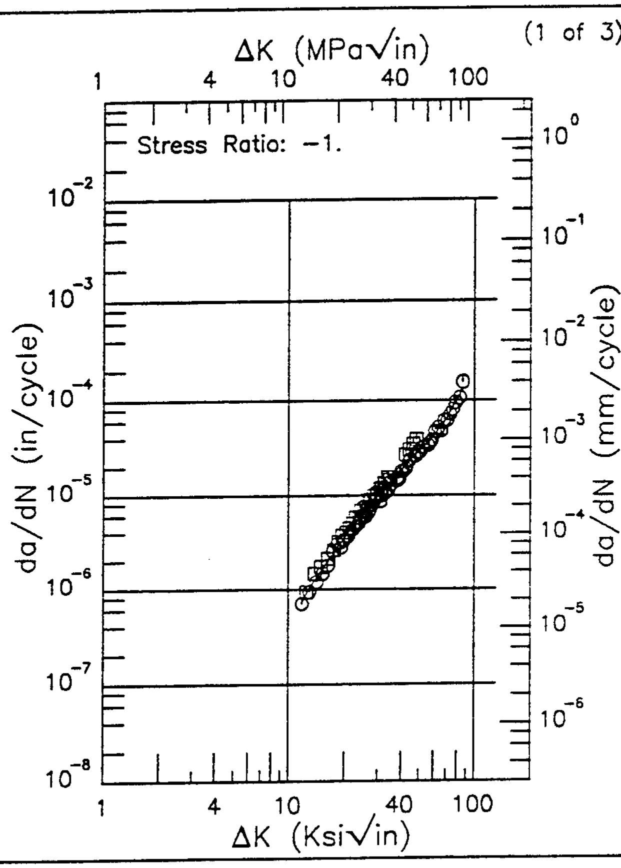
HP9-4-.30

R

Condition/Ht: UTS=220-240KSI
Form: 3.2 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L-T
Frequency: 10 Hz
Environment: L.H.A.; RT

Yield Strength: 210.5 - 212 ksi
Ult. Strength: 228.5 - 229 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 - 4 in.
Ref: MA007;MA010

(1 of 3)



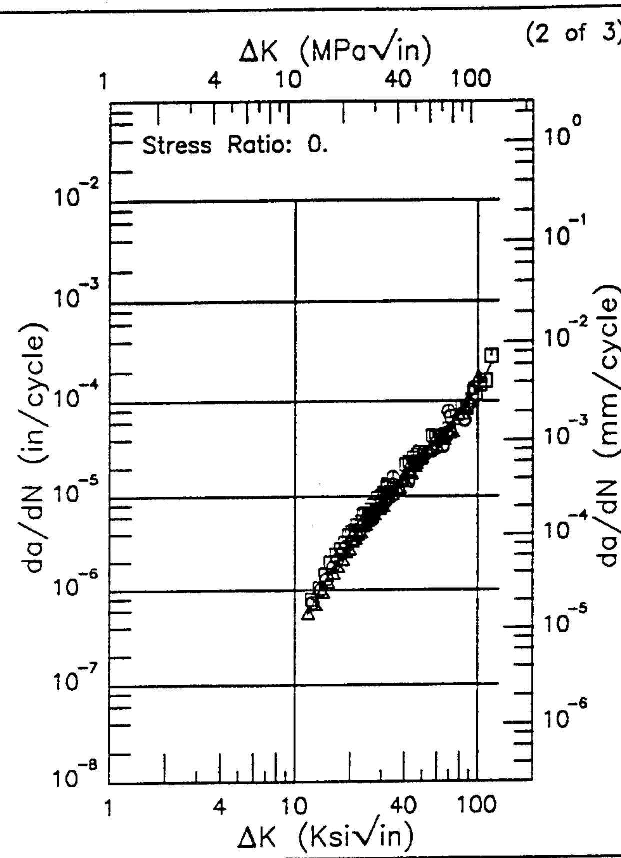
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.76 (min)	0.729
13.	1.01
16.	1.92
20.	3.59
25.	6.36
30.	9.81
35.	13.9
40.	18.5
50.	29.1
60.	42.6
70.	63.4
80.	99.7
85.73 (max)	133.

RMS % Error: 11.99

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.75 (min)	0.553
13.	0.829
16.	1.73
20.	3.37
25.	5.95
30.	8.99
35.	12.4
40.	16.3
50.	25.6
60.	37.6
70.	53.3
80.	73.8
90.	101.
100.	136.
118.22 (max)	232.

RMS % Error: 13.30

Life Prediction Ratio Summary

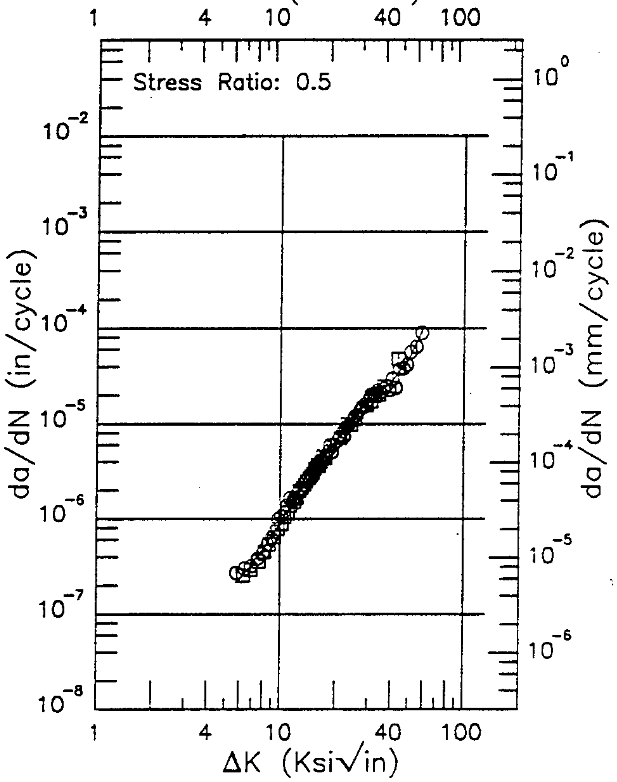
0. .5 .8 1.25 2.

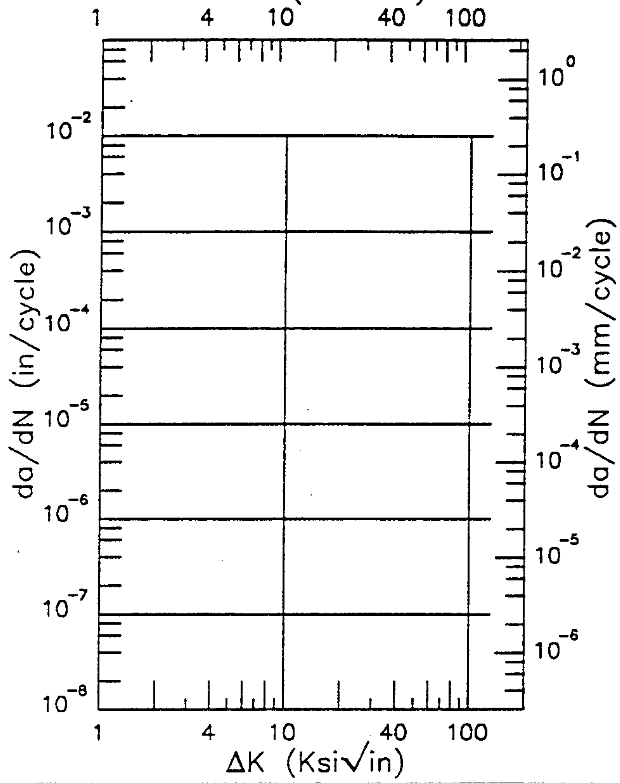
Figure 3.35.3.1.9

Condition/Ht: UTS=220-240KSI
Form: 3.2 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L-T
Frequency: 10 Hz
Environment: L.H.A.; RT

Yield Strength: 210.5 - 212 ksi
Ult. Strength: 228.5 - 229 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 - 4 in.
Ref: MA007;MA010

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.78 (min)	0.216
6.	0.234
7.	0.336
8.	0.476
9.	0.660
10.	0.893
13.	1.95
16.	3.60
20.	6.73
25.	11.7
30.	17.2
35.	22.3
40.	27.7
50.	47.4
58.56 (max)	92.0

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
9.40	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

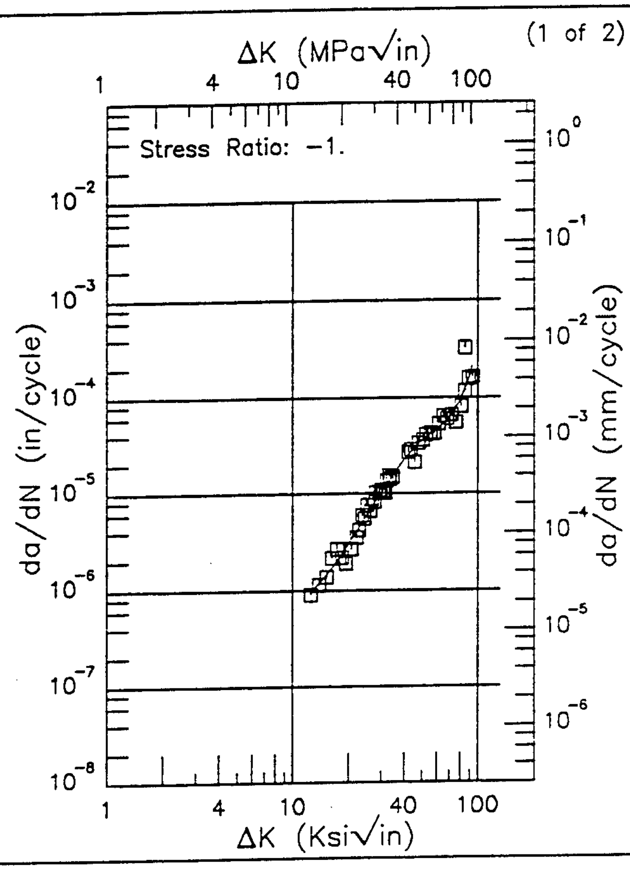
Figure 3.35.3.1.9 (Concluded)

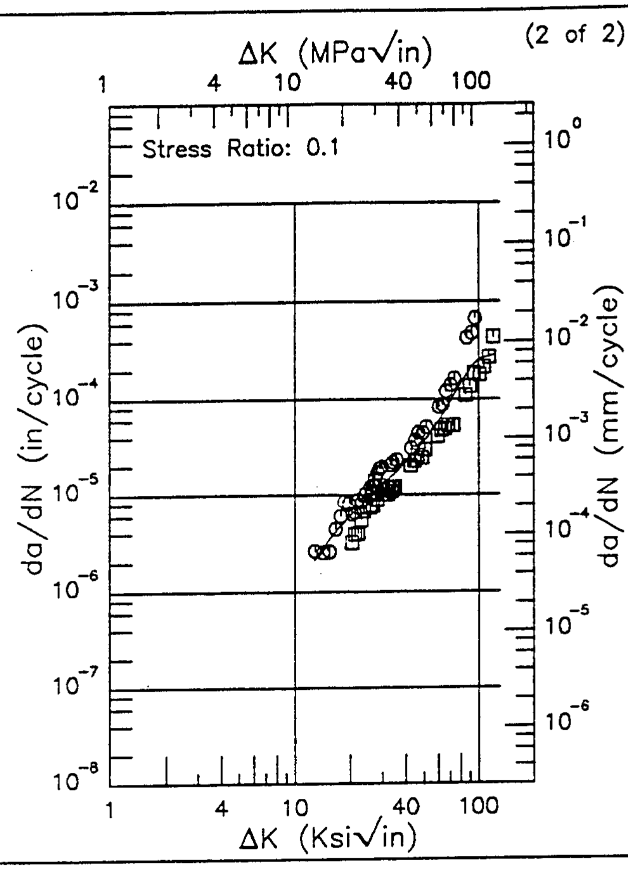
HP9-4-.30

R

Condition/Ht: UTS=220-240KSI
Form: 3.2 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L-T
Frequency: 0.1 Hz
Environment: 3.5% NACL; RT

Yield Strength: 212 ksi
Ult. Strength: 229 ksi
Specimen Thk: 0.25 in.
Specimen Width: 4 in.
Ref: MA007





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.51 (min)	0.952
13.	1.02
16.	1.63
20.	3.01
25.	5.89
30.	10.2
35.	15.9
40.	22.5
50.	35.9
60.	46.7
70.	60.9
80.	91.6
90.	166.
93.29 (max)	211.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.78 (min)	2.12
13.	2.22
16.	3.80
20.	6.12
25.	9.28
30.	12.8
35.	17.0
40.	22.0
50.	36.1
60.	58.4
70.	94.4
80.	147.
90.	208.
100.	261.
120.03 (max)	283.

RMS % Error 28.10

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error 44.06

Life Prediction Ratio Summary

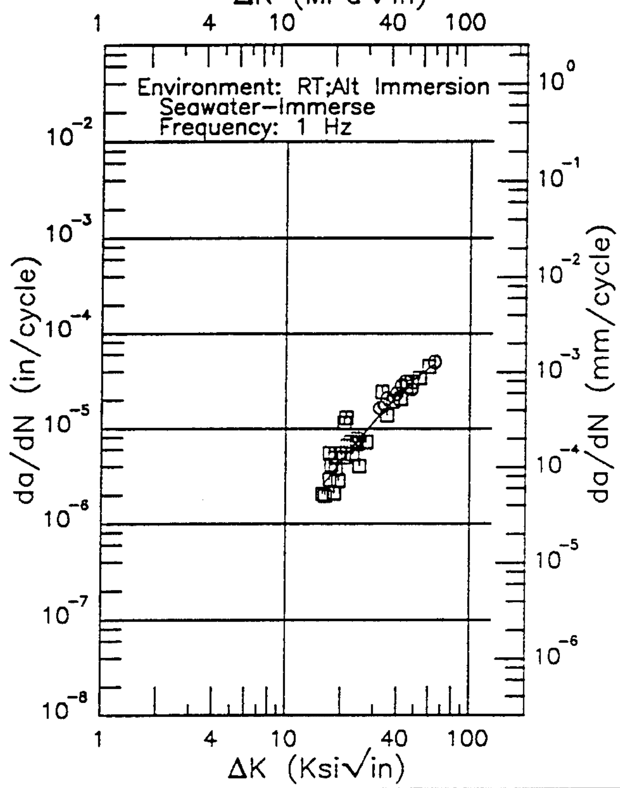
0. .5 .8 1.25 2.

Figure 3.35.3.1.10

Condition/Ht: UTS=220-240KSI
Form: 3.2 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L-T
Stress Ratio: 0.

Yield Strength: 210.5 ksi
Ult. Strength: 228.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 in.
Ref: MA010

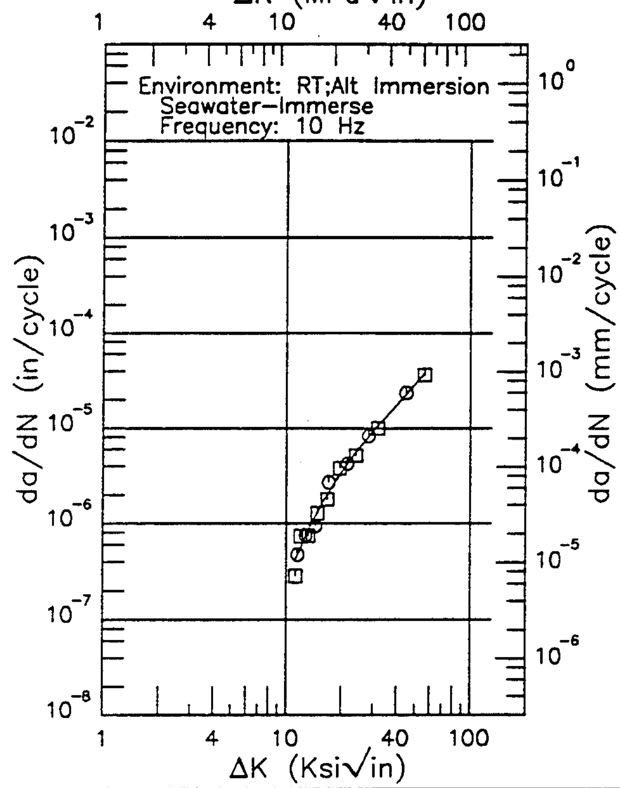
(1 of 6)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.84 (min)	2.54
16.	2.60
20.	4.51
25.	7.76
30.	11.9
35.	16.7
40.	22.0
50.	33.2
60.	43.8
63.89 (max)	47.5

RMS % Error	Life Prediction Ratio Summary
41.03	0. .5 .8 1.25 2.

(2 of 6)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.21 (min)	0.411
13.	0.790
16.	1.72
20.	3.43
25.	6.12
30.	9.31
35.	13.0
40.	17.4
50.	28.7
55.99 (max)	37.7

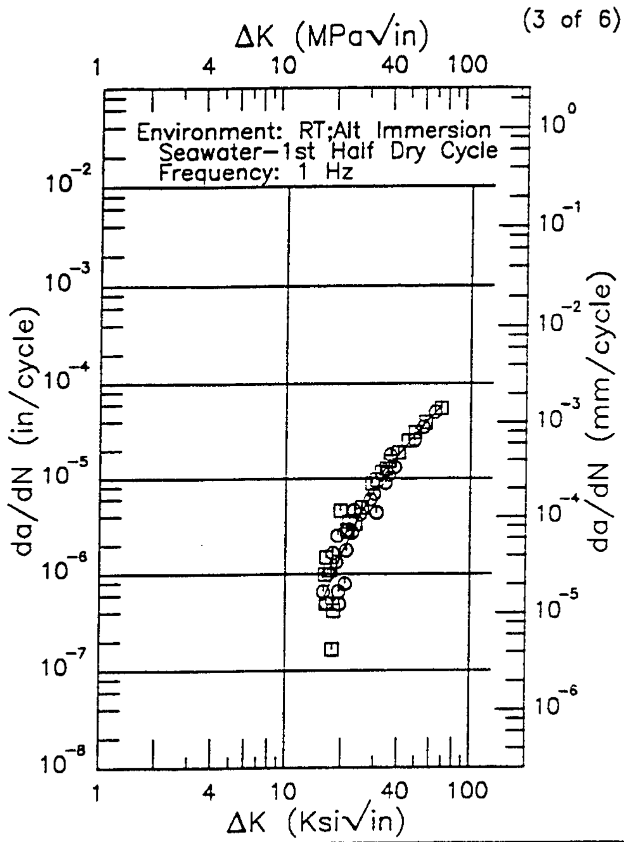
RMS % Error	Life Prediction Ratio Summary
15.67	0. .5 .8 1.25 2.

Figure 3.35.3.1.11

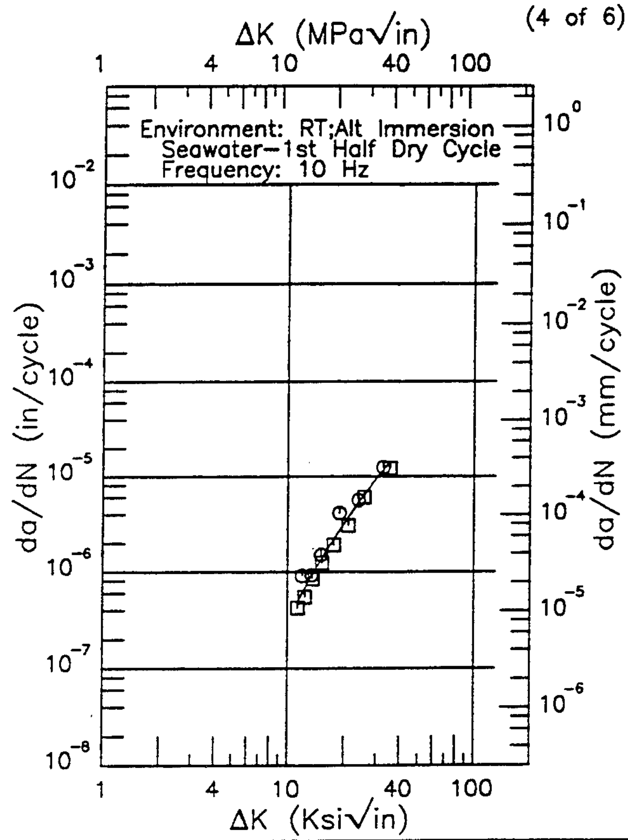
EF HP9-4-.30

Condition/Ht: UTS=220-240KSI
Form: 3.2 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L-T
Stress Ratio: 0.

Yield Strength: 210.5 ksi
Ult. Strength: 228.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 in.
Ref: MA010



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.92 (min)	0.533
16.	0.547
20.	1.62
25.	4.02
30.	7.56
35.	12.1
40.	17.4
50.	29.7
60.	43.6
68.44 (max)	56.4



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.34 (min)	0.494
13.	0.802
16.	1.60
20.	3.17
25.	5.93
30.	9.49
35.	13.7
35.32 (max)	14.0

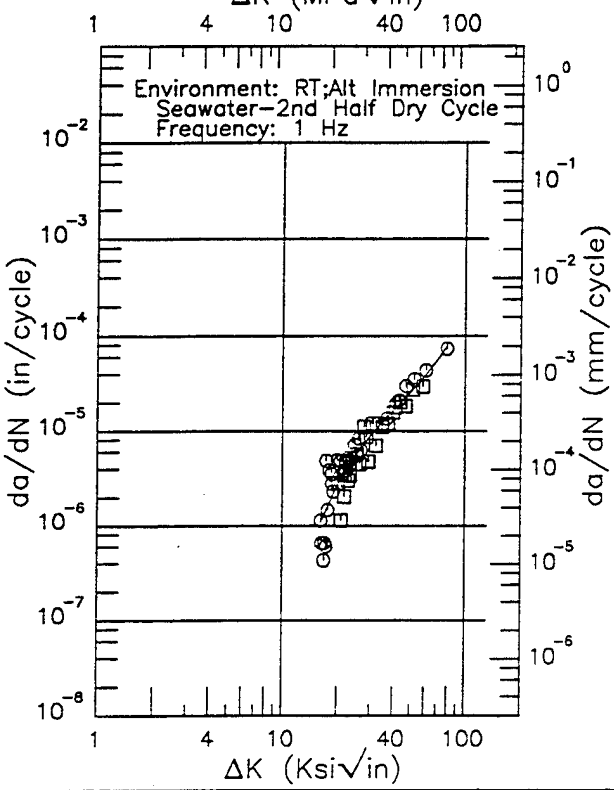
RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
52.25	0. .5 .8 1.25 2.	23.17	0. .5 .8 1.25 2.

Figure 3.35.3.1.11 (Continued)

Condition/Ht: UTS=220-240KSI
Form: 3.2 in. Billet
Specimen Type: CCP (max load specified)
Orientation: L-T
Stress Ratio: 0.

Yield Strength: 210.5 ksi
Ult. Strength: 228.5 ksi
Specimen Thk: 0.25 in.
Specimen Width: 3.9 in.
Ref: MA010

(5 of 6)



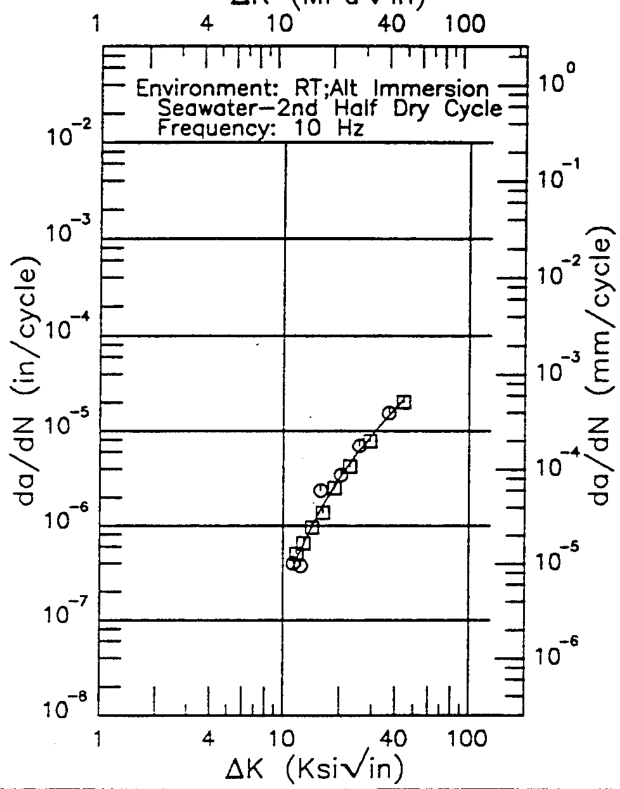
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.15 (min)	1.09
20.	2.70
25.	5.59
30.	8.98
35.	12.6
40.	16.6
50.	25.8
60.	38.2
70.	55.8
78.64 (max)	77.6

RMS % Error 47.98

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(6 of 6)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.28 (min)	0.350
13.	0.674
16.	1.53
20.	3.19
25.	5.90
30.	9.16
35.	12.9
40.	17.3
43.89 (max)	21.1

RMS % Error 20.53

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.35.3.1.11 (Concluded)

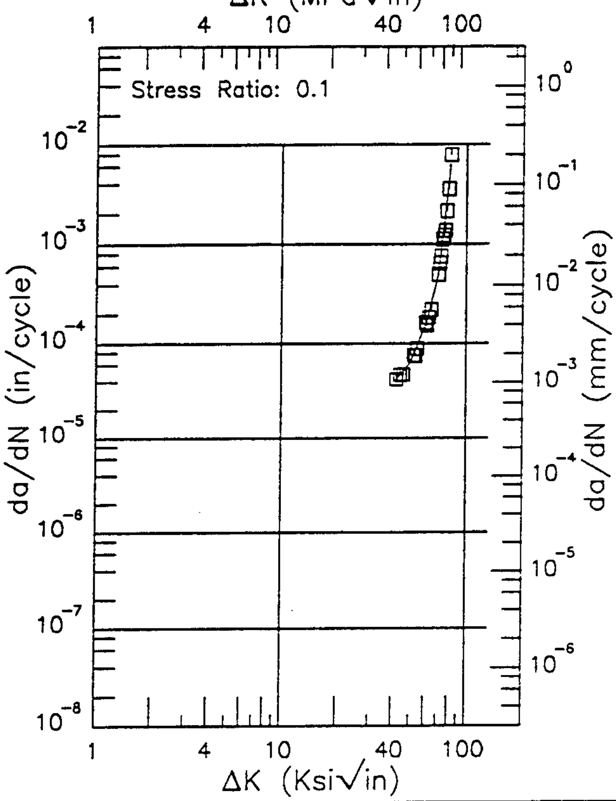
R

HP9-4-.30

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Frequency: 0.1 Hz
Environment: WATER SAT JP4; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(1 of 2)



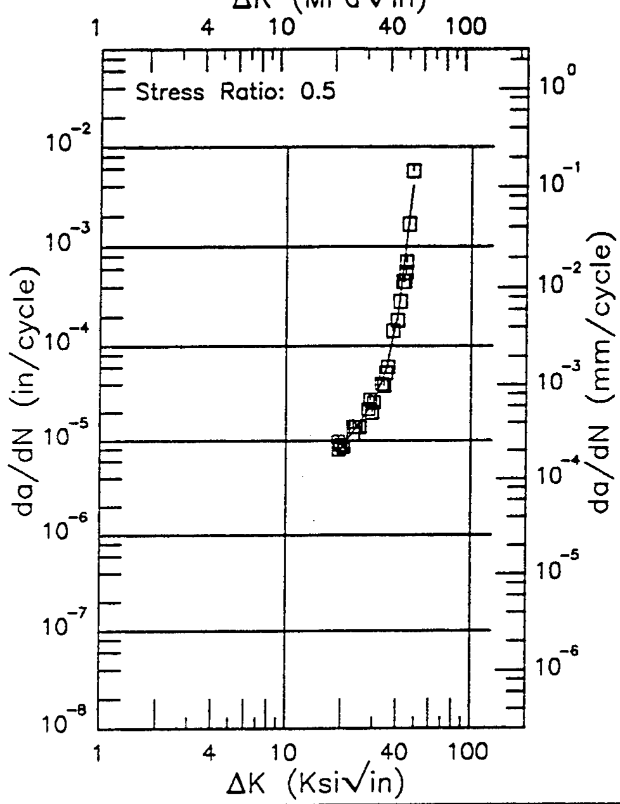
ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
42.02 (min)	42.2
50.	64.0
60.	152.
70.	476.
80.	4201.
81.35 (max)	6309.

RMS % Error 13.74

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
19.18 (min)	7.07
20.	8.46
25.	15.5
30.	25.4
35.	57.1
40.	195.
48.48 (max)	4021.

RMS % Error 20.87

Life Prediction Ratio Summary

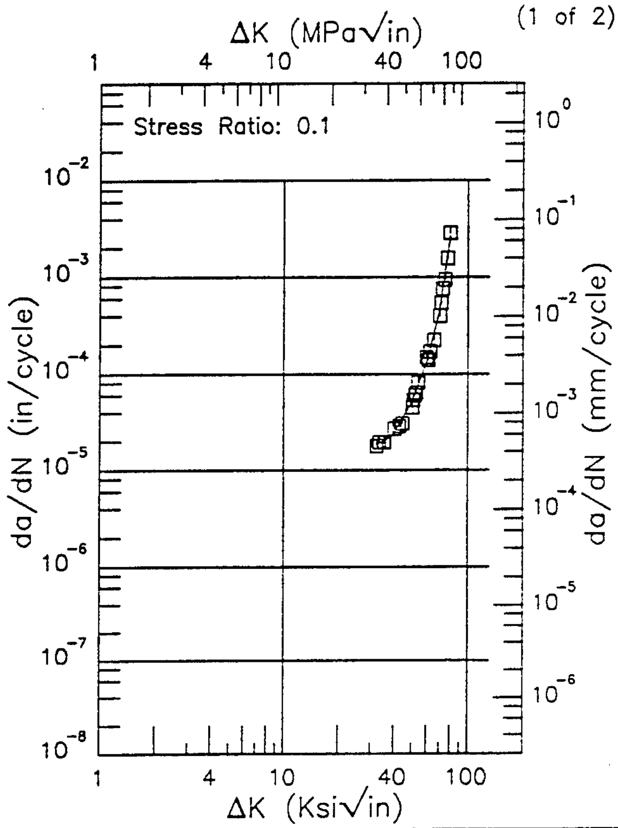
0. .5 .8 1.25 2.

Figure 3.35.3.1.12

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Frequency: 1 Hz
Environment: WATER SAT JP4; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

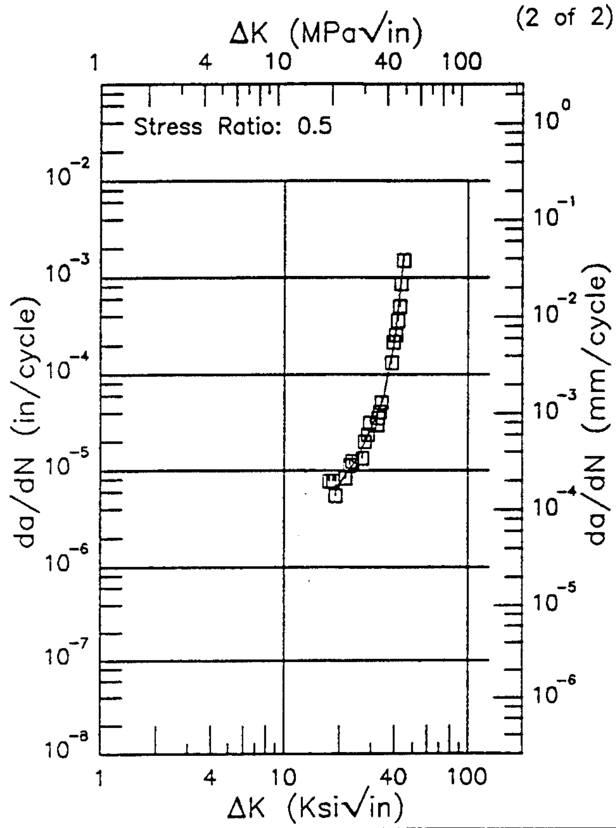
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
32.39 (min)	18.9
35.	19.6
40.	24.3
50.	51.7
60.	132.
70.	448.
79.89 (max)	2613.

RMS % Error	Life Prediction Ratio Summary
8.48	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.61 (min)	6.24
20.	7.29
25.	13.2
30.	27.0
35.	59.0
40.	214.
44.83 (max)	1646.

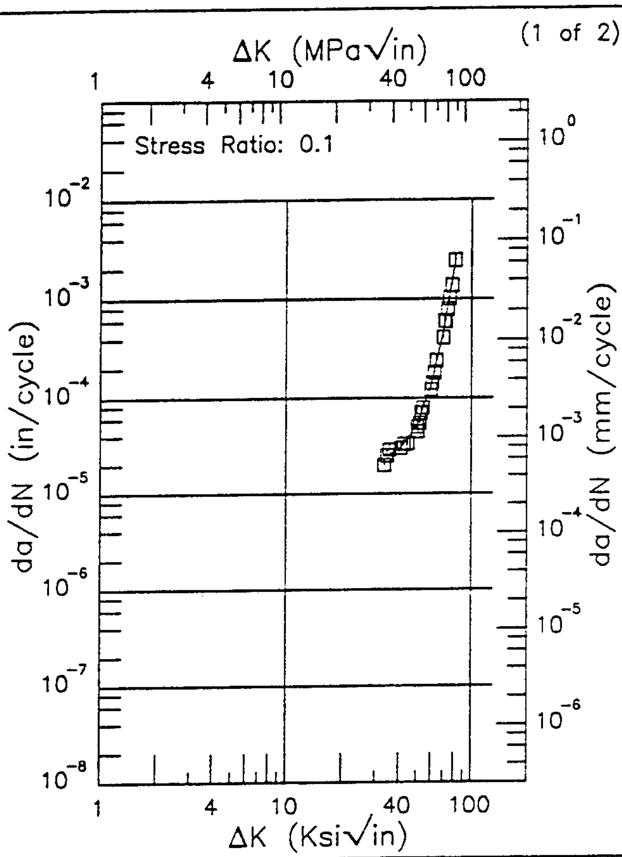
RMS % Error	Life Prediction Ratio Summary
14.78	0. .5 .8 1.25 2.

Figure 3.35.3.1.13

R — HP9-4-.30

Condition/Ht:	Yield Strength:
Form: 0.63 in. Plate	Ult. Strength:
Specimen Type: DCB	Specimen Thk:
Orientation: T-L	Specimen Width:
Frequency: 1 Hz	Ref: 88140
Environment: DIST WATER; RT	

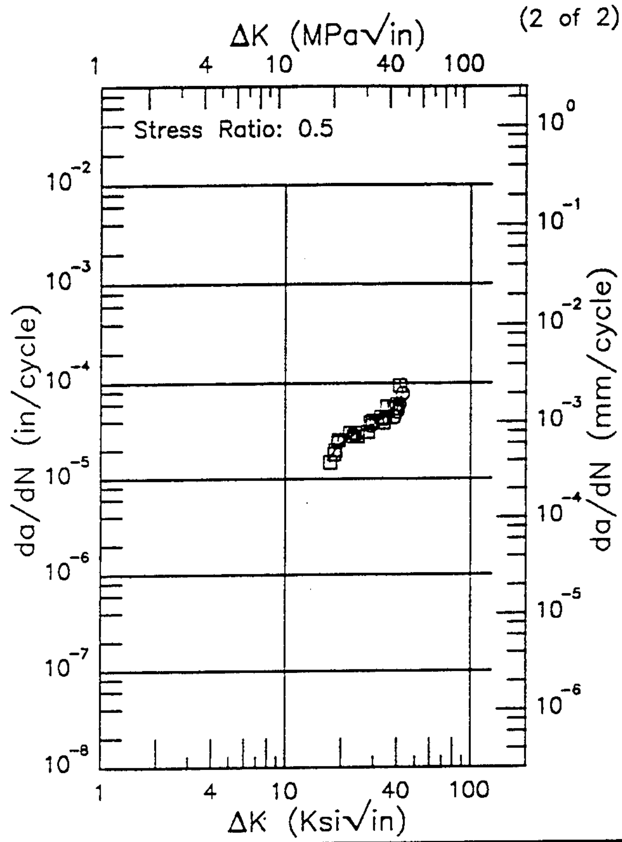
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.22 (min)	25.6
35.	25.7
40.	28.7
50.	51.7
60.	136.
70.	472.
80.	1984.
81.07 (max)	2335.

RMS % Error	Life Prediction Ratio Summary
8.95	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.35 (min)	17.0
20.	24.0
25.	31.8
30.	37.3
35.	45.6
40.	61.2
42.67 (max)	74.9

RMS % Error	Life Prediction Ratio Summary
12.60	0. .5 .8 1.25 2.

Figure 3.35.3.1.14

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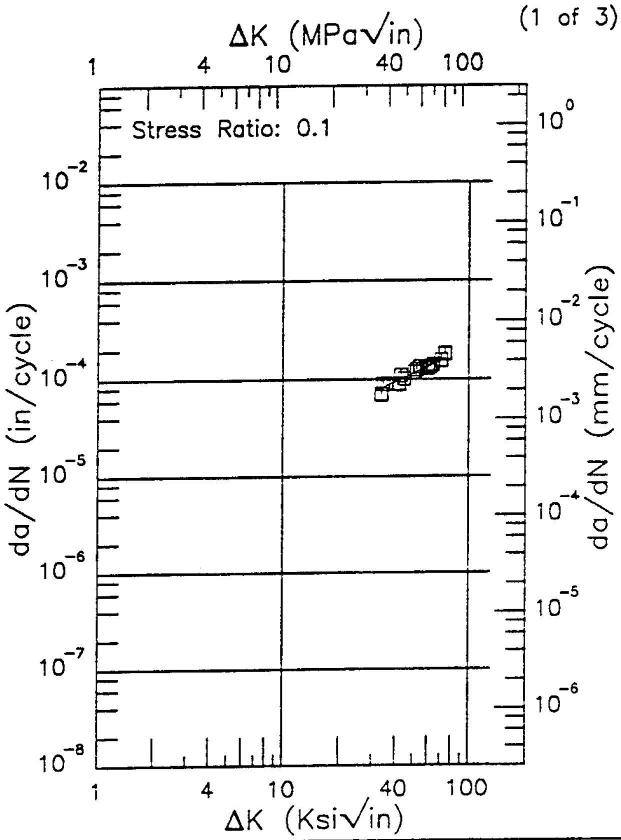
HP9-4-.30

R

Condition/Ht:	Yield Strength:
Form: 0.63 in. Plate	Ult. Strength:
Specimen Type: DCB	Specimen Thk:
Orientation: T-L	Specimen Width:
Frequency: 0.1 Hz	Ref: 88140
Environment: 3.5% NACL; RT	

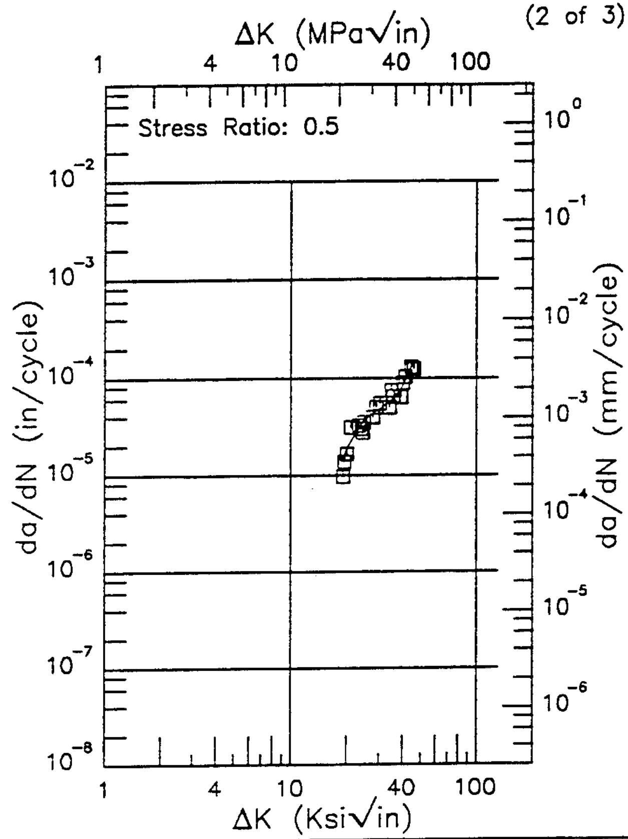
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.47 (min)	81.3
35.	84.1
40.	93.6
50.	114.
60.	135.
70.	156.
74.38 (max)	165.

RMS % Error	Life Prediction Ratio Summary
6.96	0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.21 (min)	15.1
20.	18.7
25.	37.6
30.	48.0
35.	59.1
40.	82.0
45.63 (max)	145.

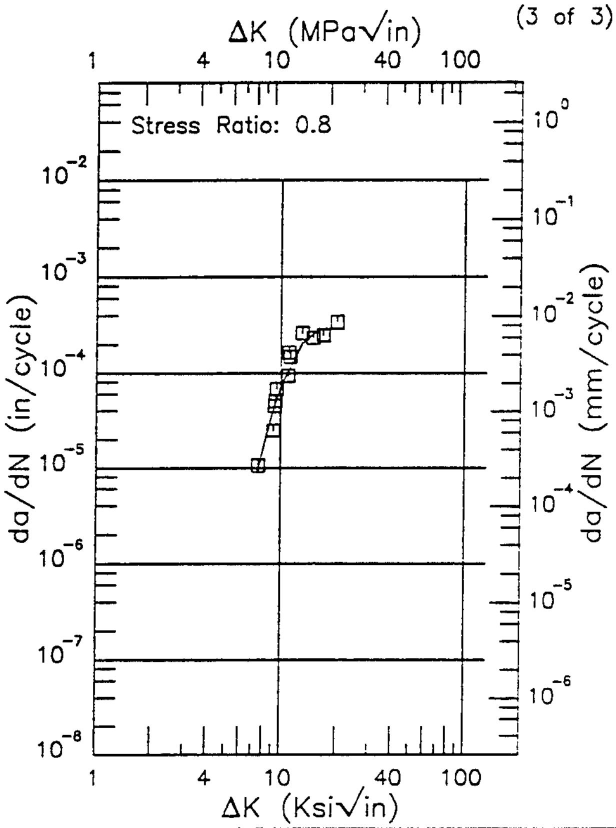
RMS % Error	Life Prediction Ratio Summary
17.50	0. .5 .8 1.25 2.

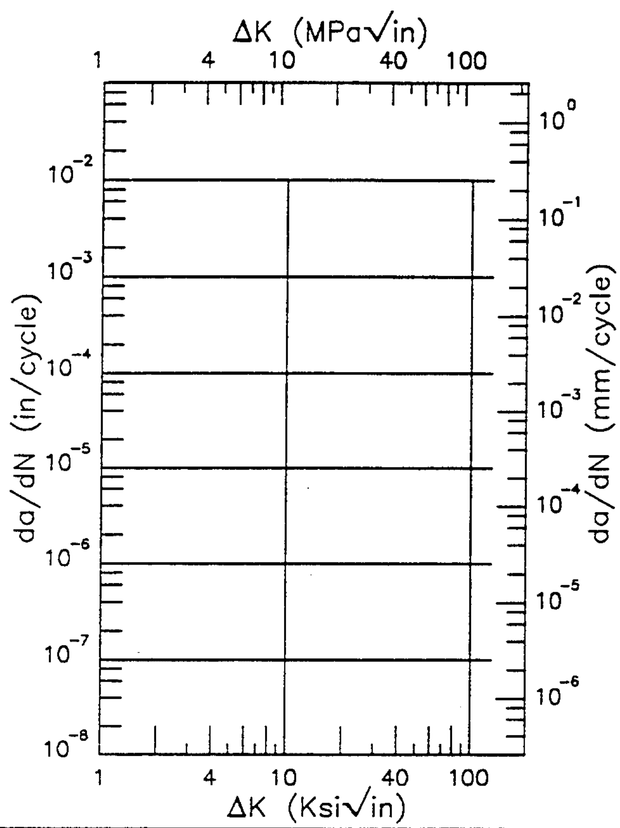
Figure 3.35.3.1.15

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Frequency: 0.1 Hz
Environment: 3.5% NACL; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.53 (min)	9.22
8.	15.6
9.	37.7
10.	71.3
13.	201.
16.	287.
20.	293.
20.05 (max)	293.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
27.33	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

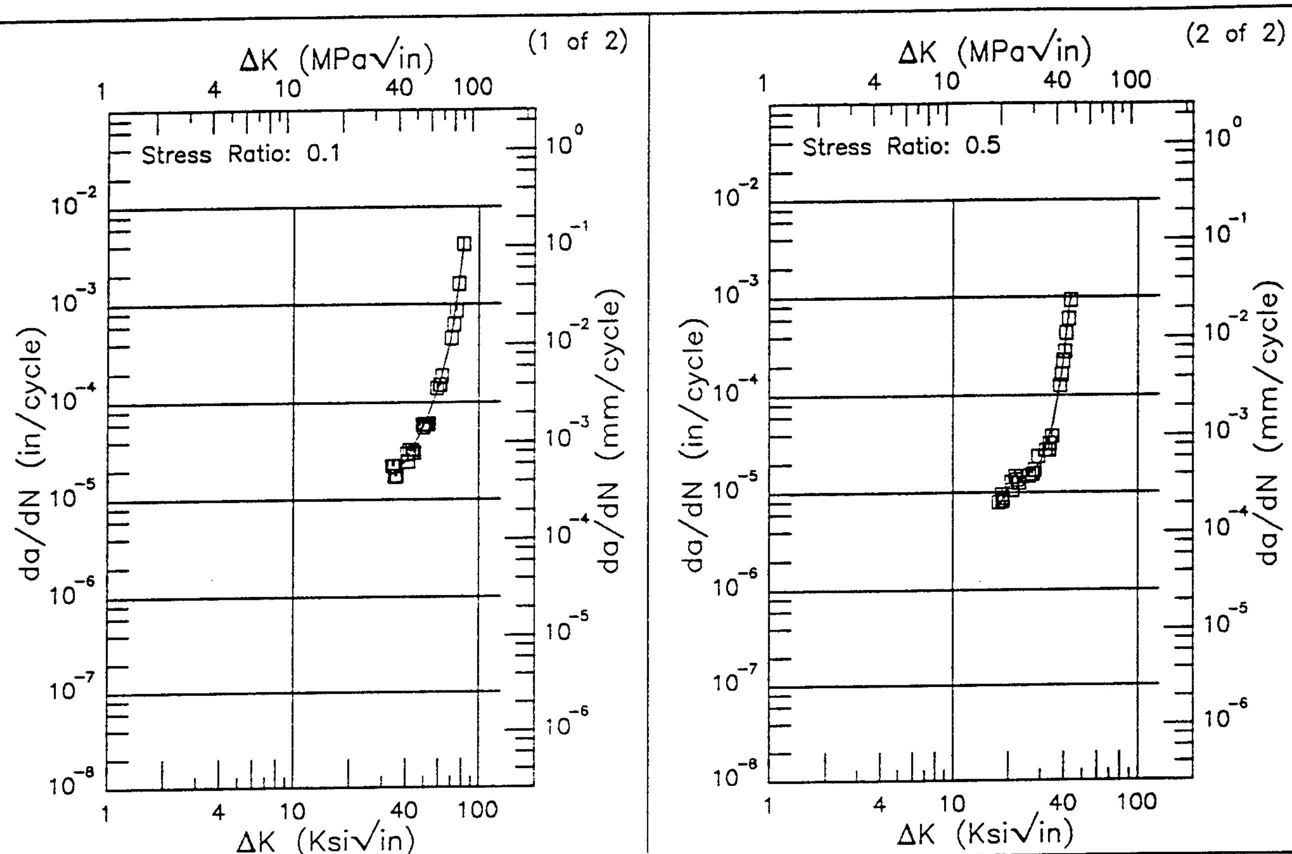
Figure 3.35.3.1.15 (Concluded)

R

HP9-4-.30

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Frequency: 1 Hz
Environment: 3.5% NACL; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.69 (min)	18.2
35.	19.0
40.	25.0
50.	56.5
60.	139.
70.	430.
80.	2669.
81.70 (max)	3963.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.66 (min)	7.08
20.	11.3
25.	14.4
30.	20.4
35.	51.2
40.	251.
43.14 (max)	946.

RMS % Error	Life Prediction Ratio Summary
11.84	0. .5 .8 1.25 2.

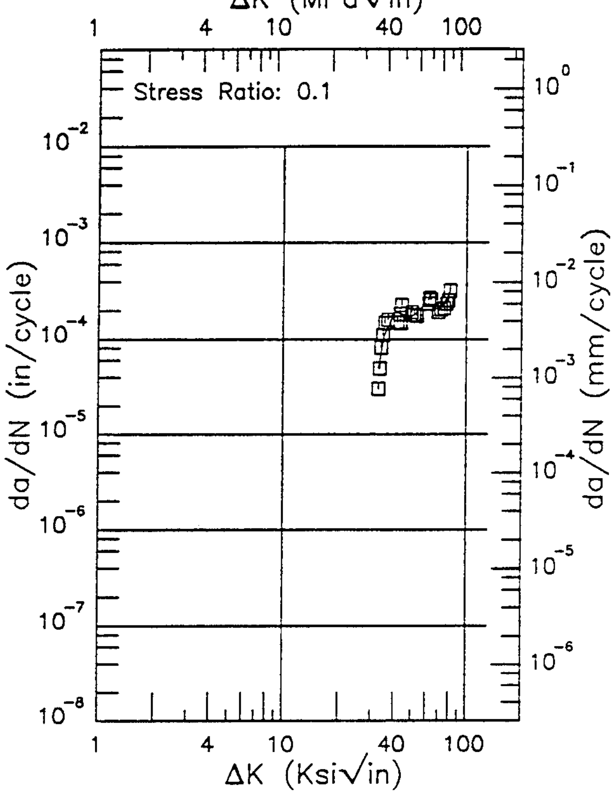
RMS % Error	Life Prediction Ratio Summary
11.87	0. .5 .8 1.25 2.

Figure 3.35.3.1.16

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Frequency: 0.1 - 1 Hz
Environment: S.T.W.; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(1 of 2)



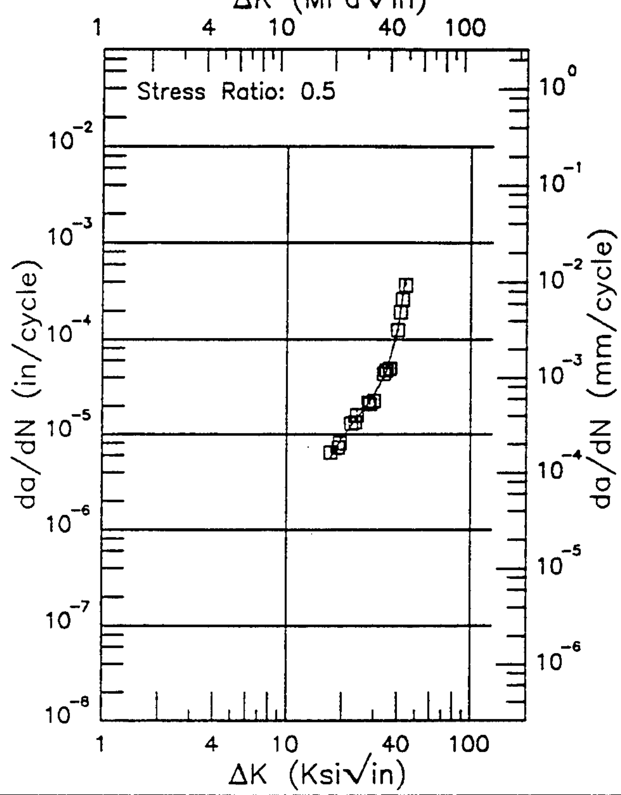
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
32.86 (min)	50.1
35.	107.
40.	193.
50.	173.
60.	237.
70.	206.
80.	295.
80.85 (max)	330.

RMS % Error 17.07

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.33 (min)	5.76
20.	9.12
25.	16.0
30.	25.8
35.	45.8
40.	125.
43.96 (max)	419.

RMS % Error 7.95

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.35.3.1.17

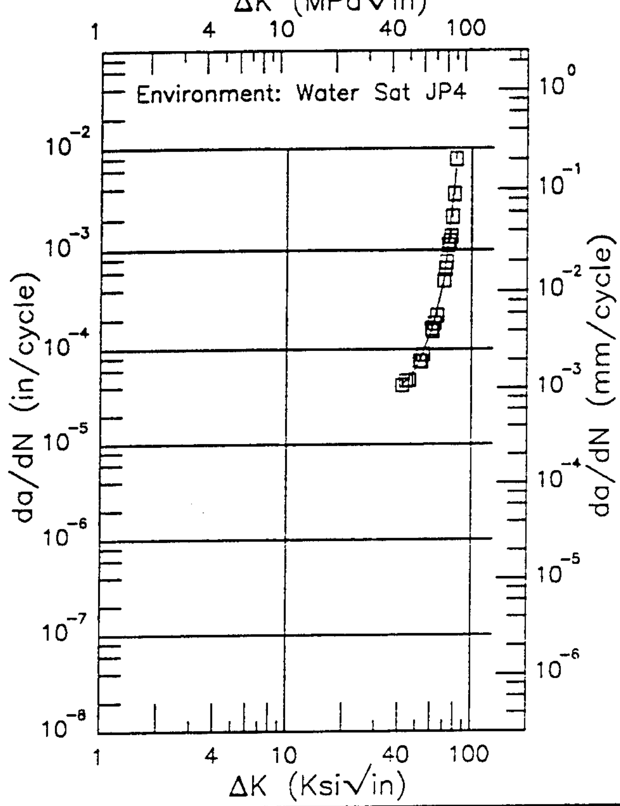
E

HP9-4-.30

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.1
Frequency: 0.1 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

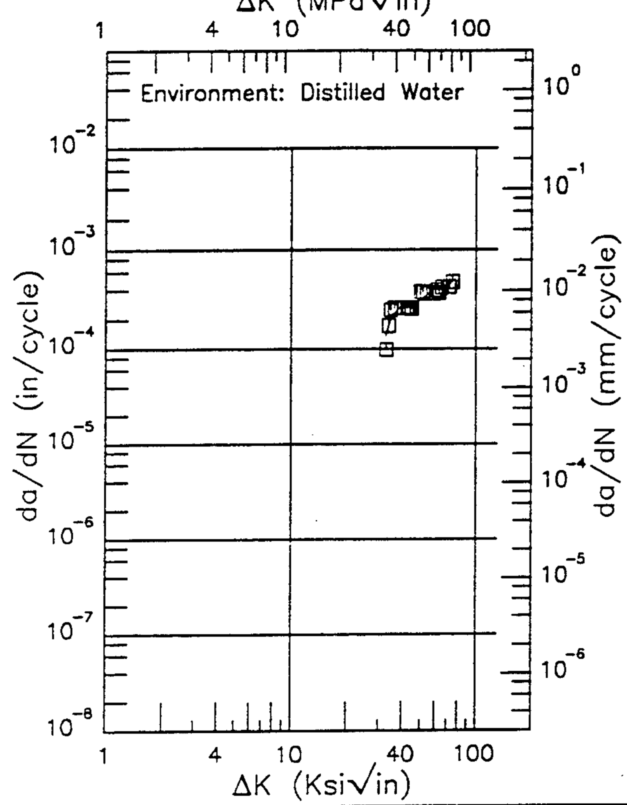
(1 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
42.02 (min)	42.2
50.	64.0
60.	152.
70.	476.
80.	4201.
81.35 (max)	6309.

RMS % Error	Life Prediction Ratio Summary
13.74	0. .5 .8 1.25 2.

(2 of 4)



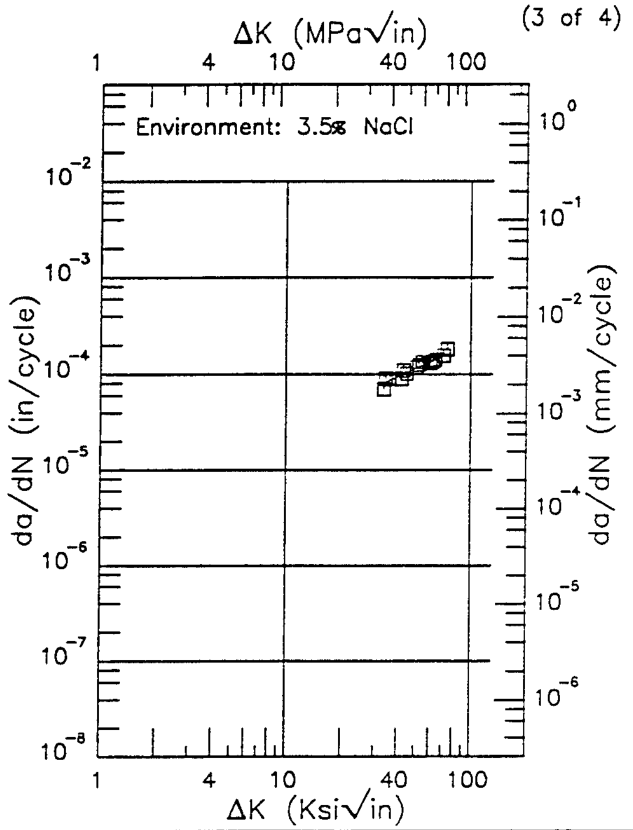
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
32.63 (min)	138.
35.	217.
40.	282.
50.	316.
60.	417.
70.	392.
74.25 (max)	510.

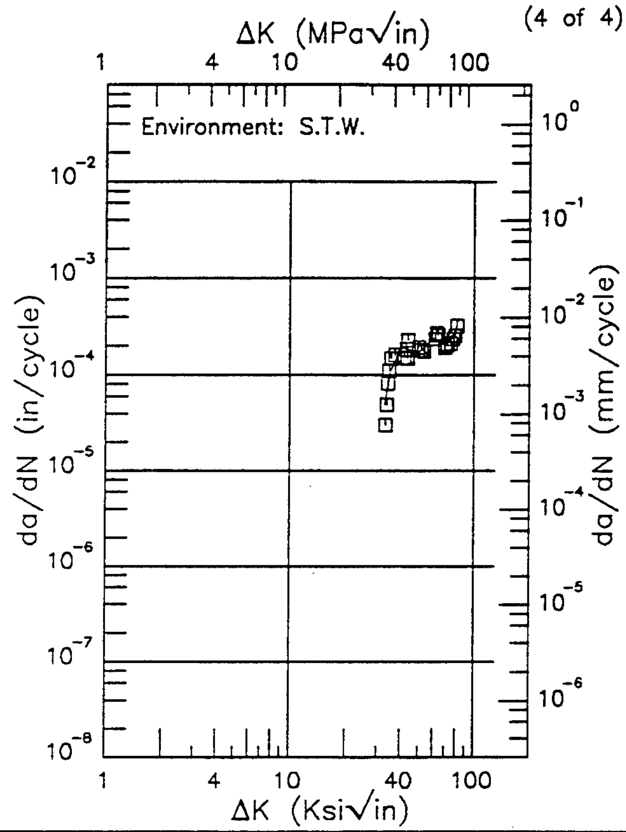
RMS % Error	Life Prediction Ratio Summary
13.42	0. .5 .8 1.25 2.

Figure 3.35.3.1.18

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.1
Frequency: 0.1 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.47 (min)	81.3
35.	84.1
40.	93.6
50.	114.
60.	135.
70.	156.
74.38 (max)	165.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
32.86 (min)	50.1
35.	107.
40.	193.
50.	173.
60.	237.
70.	206.
80.	295.
80.85 (max)	330.

RMS % Error	Life Prediction Ratio Summary
6.96	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
17.07	0. .5 .8 1.25 2.

Figure 3.35.3.1.18 (Concluded)

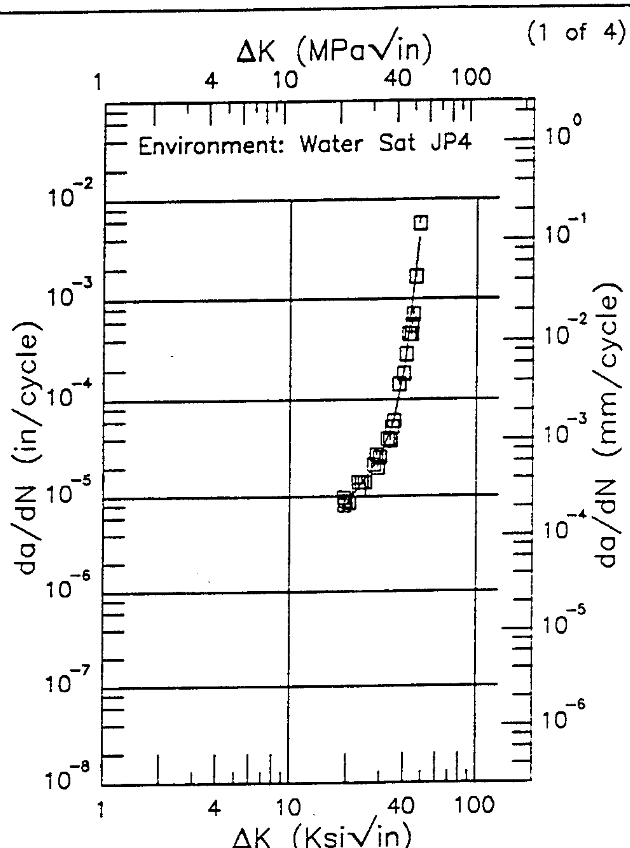
E

HP9-4-.30

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.5
Frequency: 0.1 - 1 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

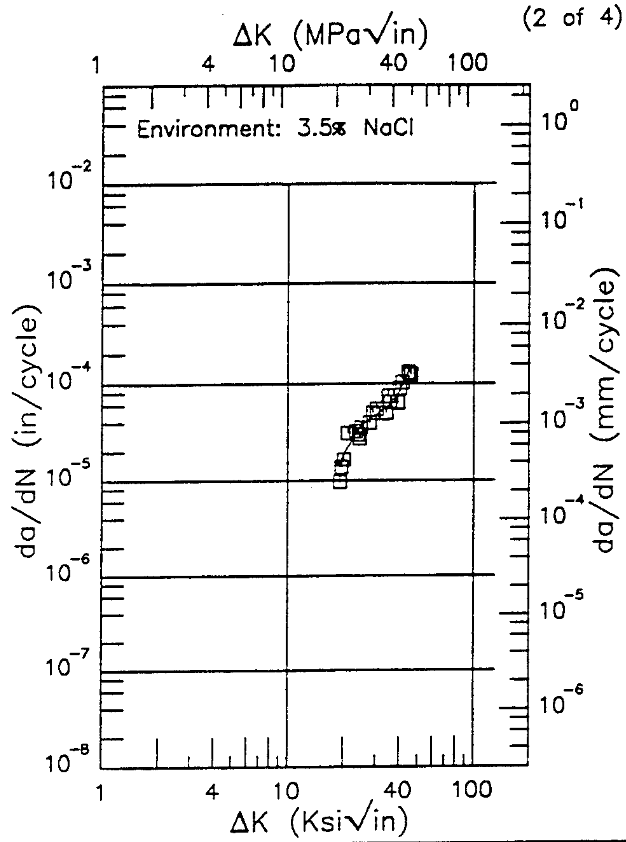
(1 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.18 (min)	7.07
20.	8.46
25.	15.5
30.	25.4
35.	57.1
40.	195.
48.48 (max)	4021.

RMS % Error	Life Prediction Ratio Summary
20.87	0. .5 .8 1.25 2.

(2 of 4)



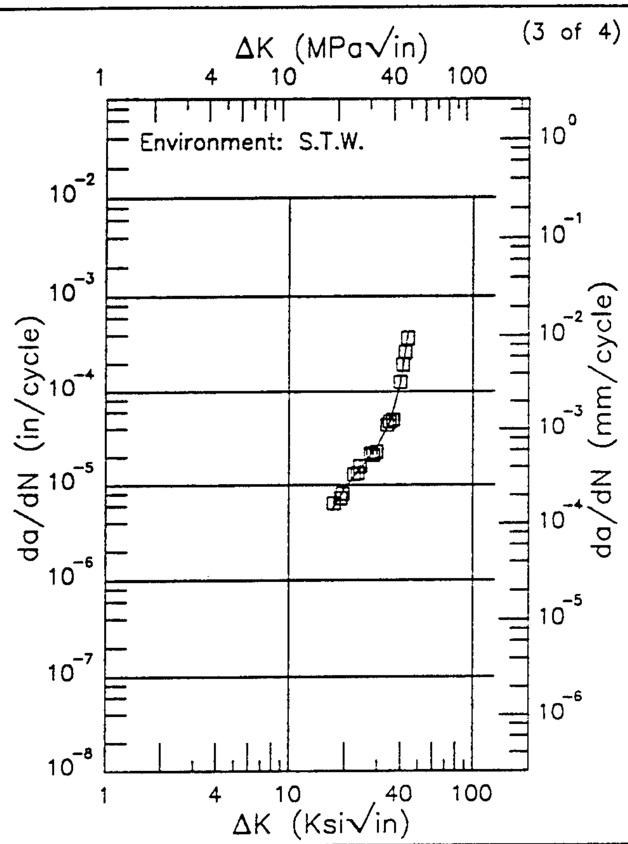
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.21 (min)	15.1
20.	18.7
25.	37.6
30.	48.0
35.	59.1
40.	82.0
45.63 (max)	145.

RMS % Error	Life Prediction Ratio Summary
17.50	0. .5 .8 1.25 2.

Figure 3.35.3.1.19

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.5
Frequency: 0.1 – 1 Hz

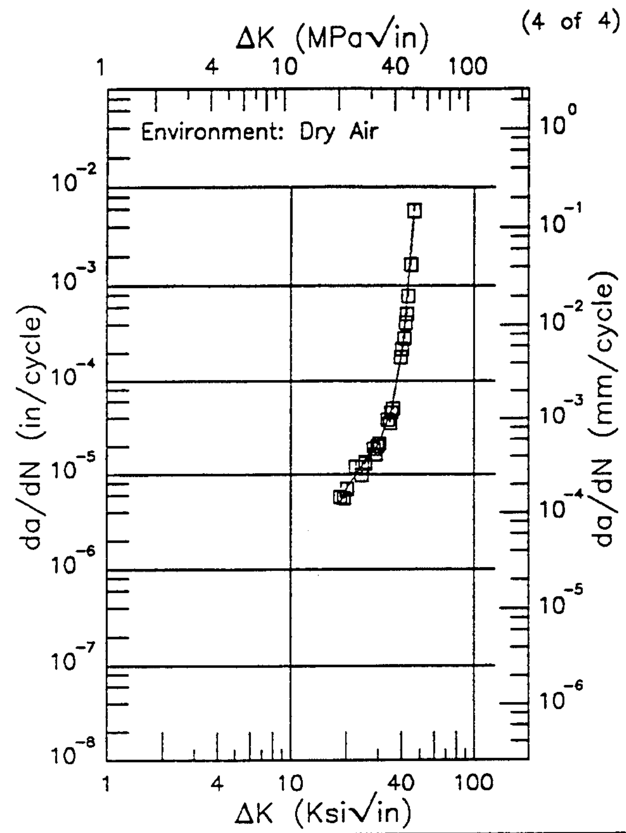
Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.33 (min)	5.76
20.	9.12
25.	16.0
30.	25.8
35.	45.8
40.	125.
43.96 (max)	419.

RMS % Error 7.95

Life Prediction Ratio Summary
0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
18.49 (min)	4.94
20.	7.03
25.	12.9
30.	21.0
35.	45.0
40.	190.
46.29 (max)	5059.

RMS % Error 15.76

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

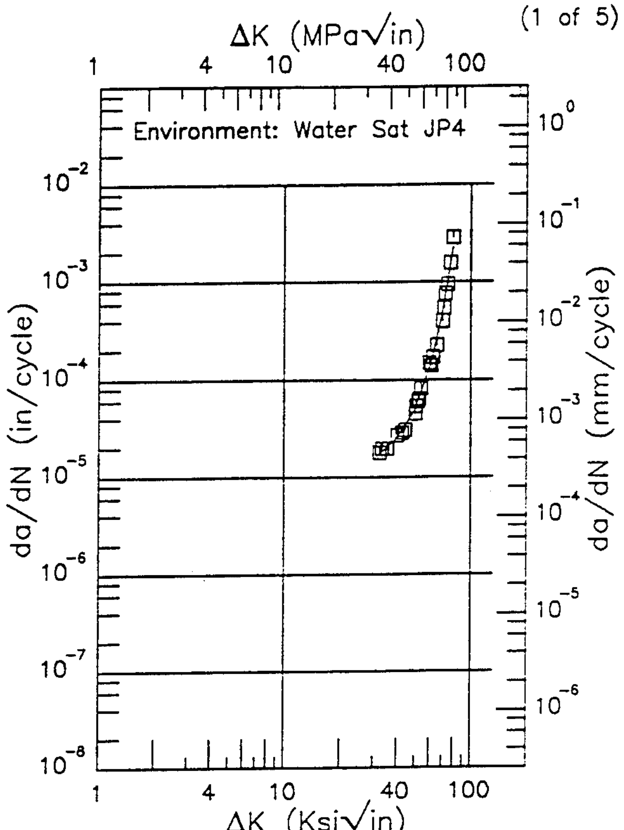
Figure 3.35.3.1.19 (Concluded)

E

HP9-4-.30

Condition/Ht:	Yield Strength:
Form: 0.63 in. Plate	Ult. Strength:
Specimen Type: DCB	Specimen Thk:
Orientation: T-L	Specimen Width:
Stress Ratio: 0.1	Ref: 88140
Frequency: 1 Hz	

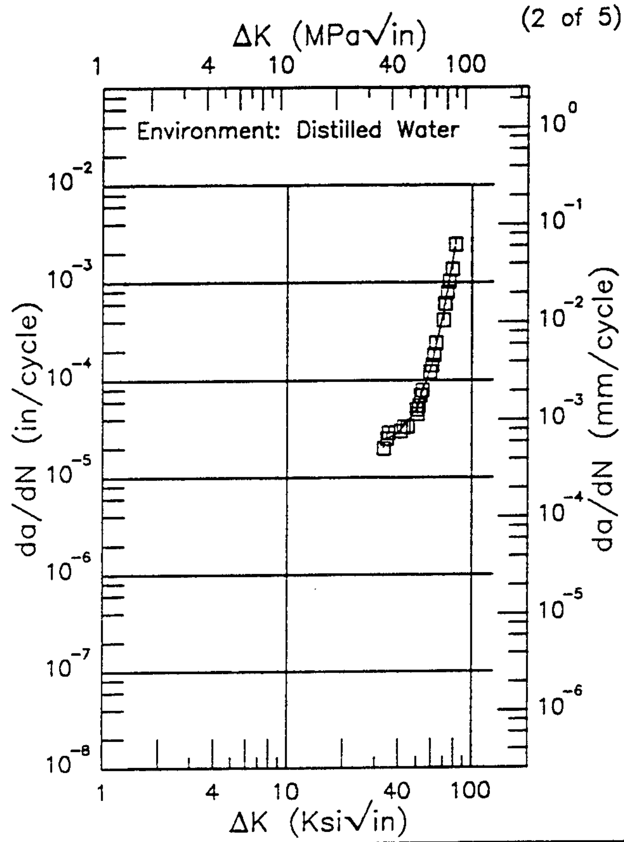
(1 of 5)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
32.39 (min)	17.4
35.	19.8
40.	25.5
50.	49.2
60.	131.
70.	480.
79.89 (max)	2259.

RMS % Error	Life Prediction Ratio Summary
9.92	0. .5 .8 1.25 2.

(2 of 5)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
33.22 (min)	25.3
35.	25.7
40.	28.9
50.	51.3
60.	136.
70.	478.
80.	1949.
81.07 (max)	2277.

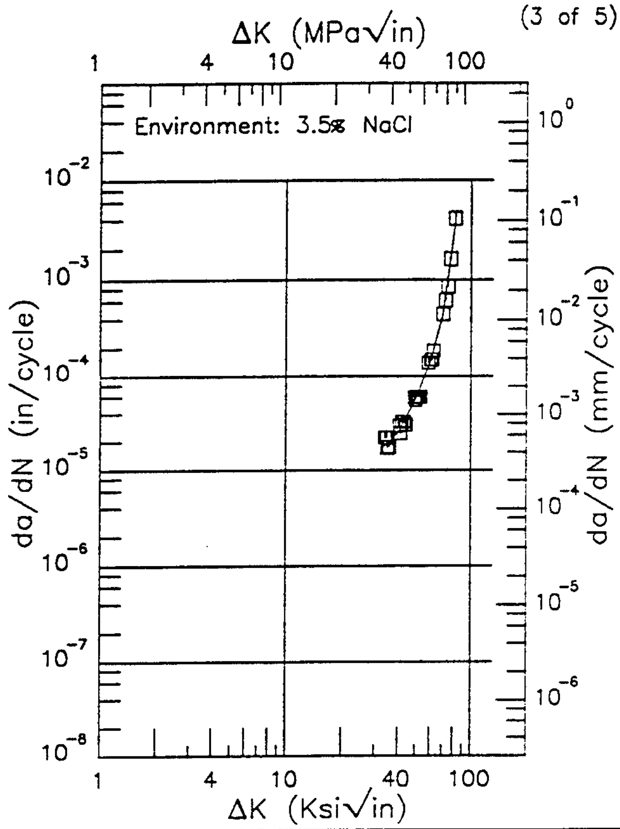
RMS % Error	Life Prediction Ratio Summary
8.77	0. .5 .8 1.25 2.

Figure 3.35.3.1.20

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.1
Frequency: 1 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(3 of 5)



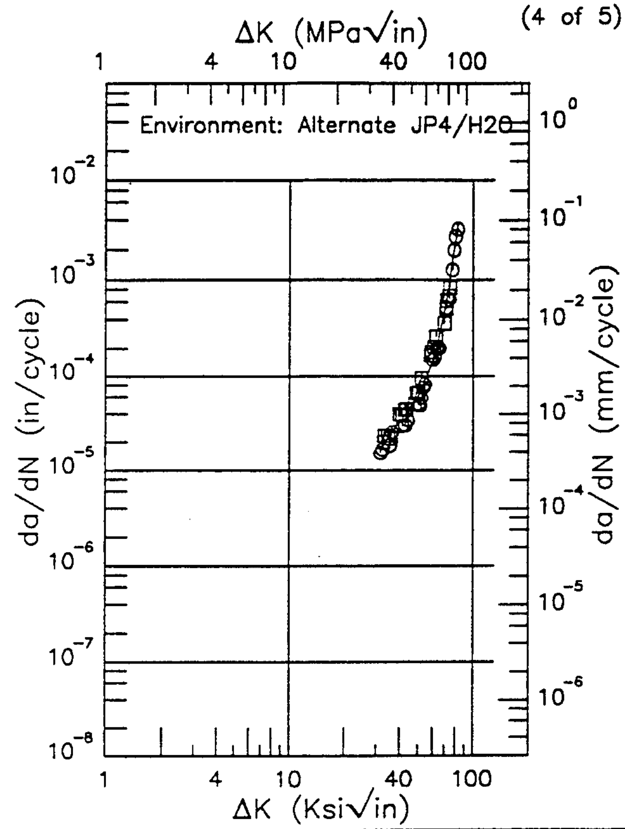
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.69 (min)	18.2
35.	19.0
40.	25.0
50.	56.5
60.	139.
70.	430.
80.	2669.
81.70 (max)	3963.

RMS % Error 11:84

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(4 of 5)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
31.49 (min)	16.3
35.	23.3
40.	32.8
50.	60.1
60.	141.
70.	474.
80.	2264.
82.06 (max)	3250.

RMS % Error 17.36

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.35.3.1.20 (Continued)

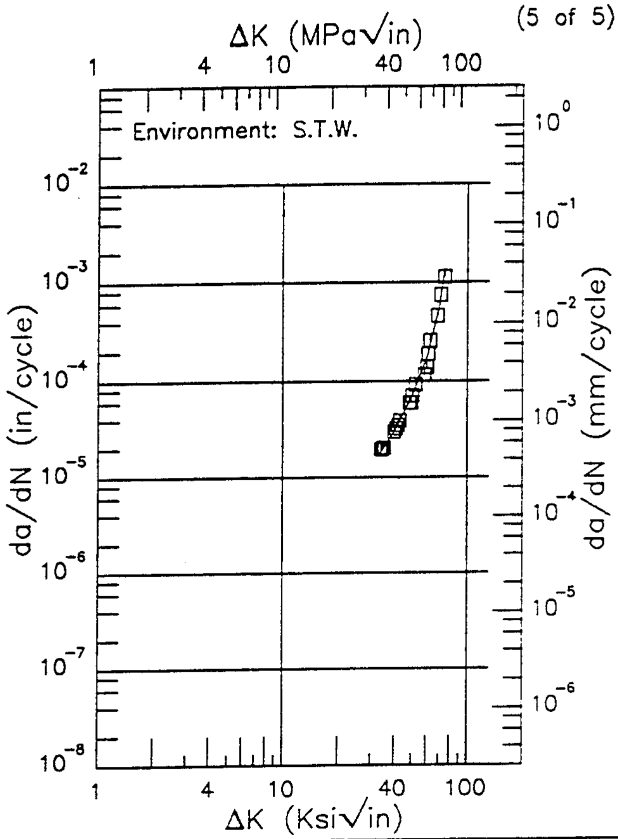
E

HP9-4-.30

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.1
Frequency: 1 Hz

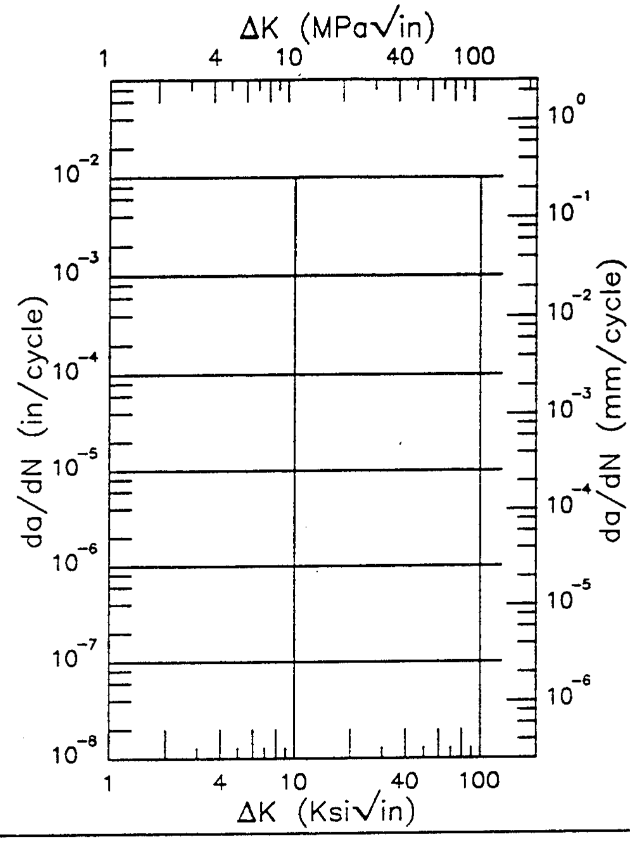
Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(5 of 5)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.79 (min)	18.3
35.	20.3
40.	30.4
50.	68.8
60.	168.
70.	567.
74.63 (max)	1179.

RMS % Error	Life Prediction Ratio Summary
8.34	0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.35.3.1.20 (Concluded)

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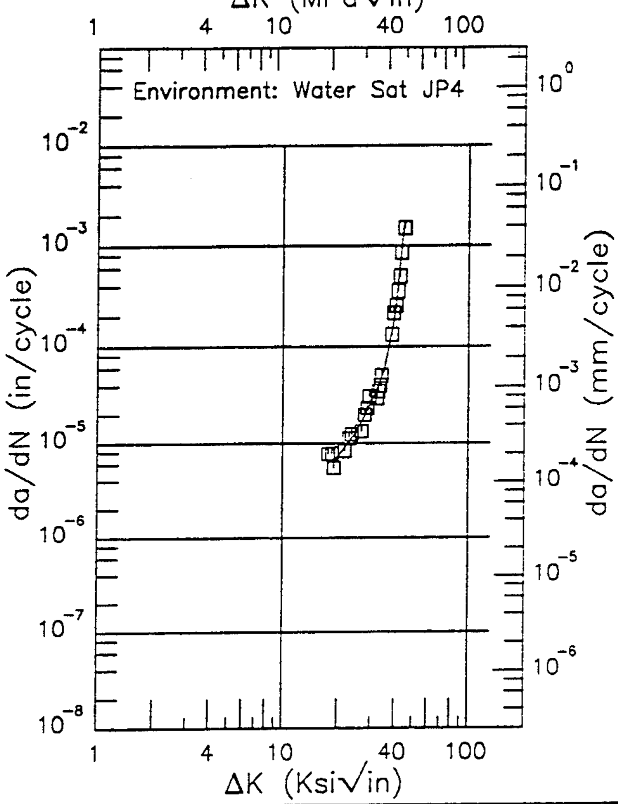
E

HP9-4-.30

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.5
Frequency: 1 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

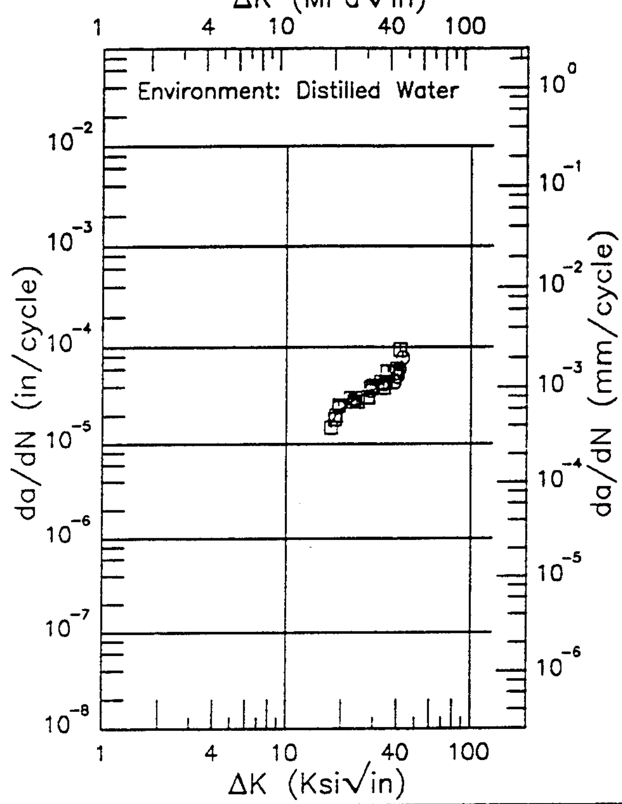
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.61 (min)	6.24
20.	7.29
25.	13.2
30.	27.0
35.	59.0
40.	214.
44.83 (max)	1646.

RMS % Error	Life Prediction Ratio Summary
14.78	0. .5 .8 1.25 2.

(2 of 3)



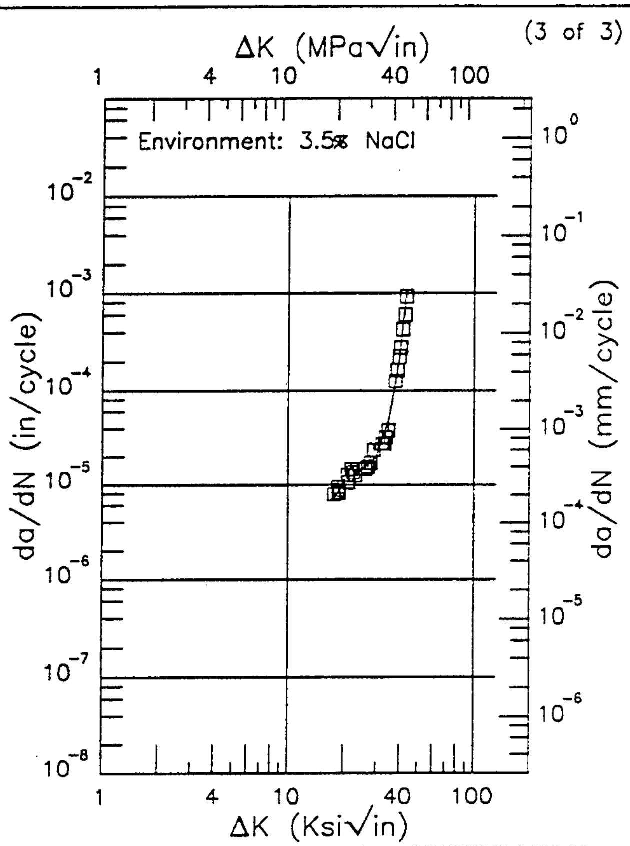
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.35 (min)	17.0
20.	24.0
25.	31.8
30.	37.3
35.	45.6
40.	61.2
42.67 (max)	74.9

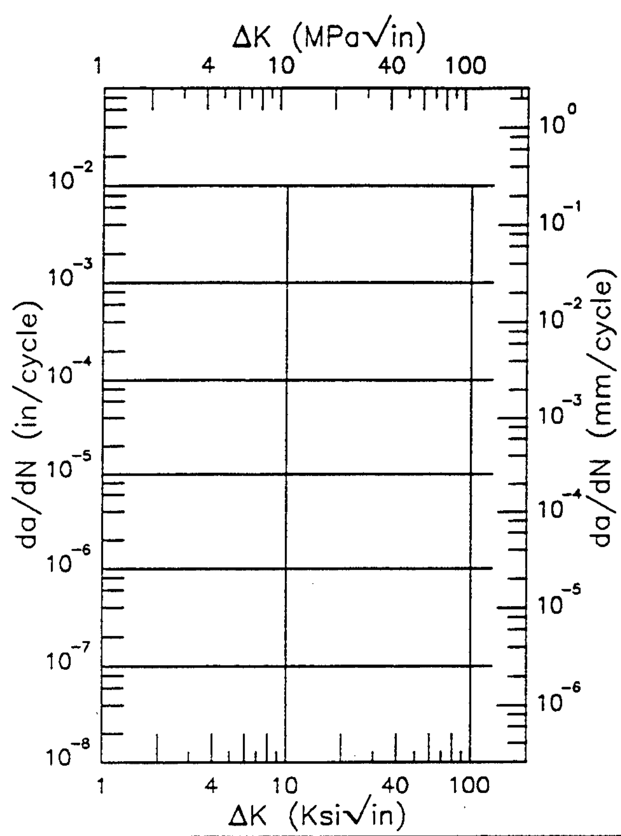
RMS % Error	Life Prediction Ratio Summary
12.60	0. .5 .8 1.25 2.

Figure 3.35.3.1.21

Condition/Ht:	
Form: 0.63 in. Plate	Yield Strength:
Specimen Type: DCB	Ult. Strength:
Orientation: T-L	Specimen Thk:
Stress Ratio: 0.5	Specimen Width:
Frequency: 1 Hz	Ref: 88140

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.66 (min)	7.08
20.	11.3
25.	14.4
30.	20.4
35.	51.2
40.	251.
43.14 (max)	946.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
11.87	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.35.3.1.21 (Concluded)

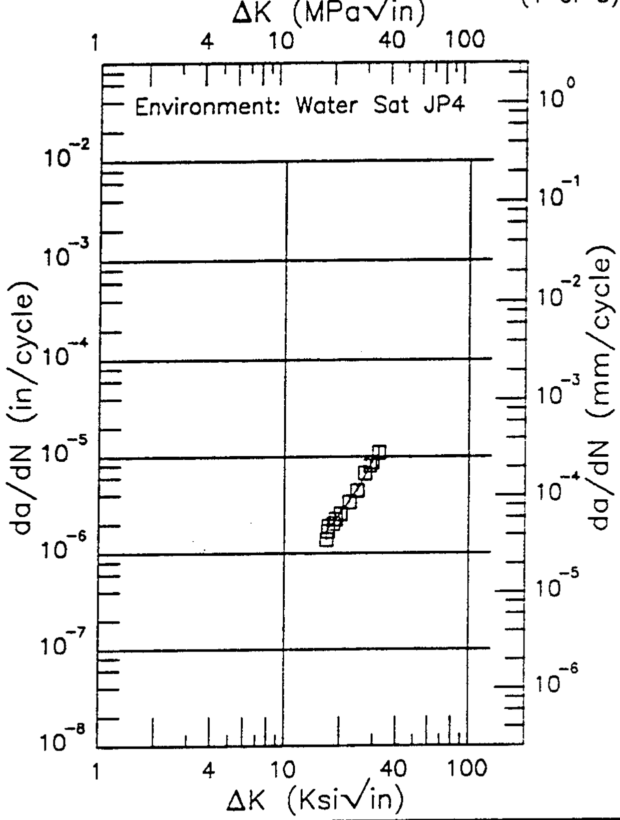
HP9-4-.30

E

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.
Frequency: 15 Hz

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

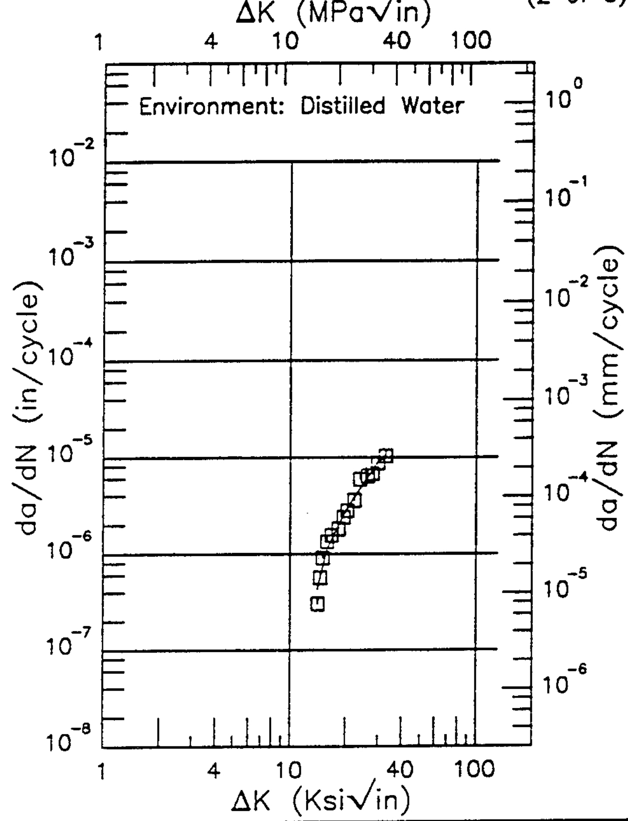
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.82 (min)	1.67
20.	2.54
25.	4.81
30.	9.24
32.11 (max)	10.6

RMS % Error	Life Prediction Ratio Summary
6.21	0. .5 .8 1.25 2.

(2 of 3)



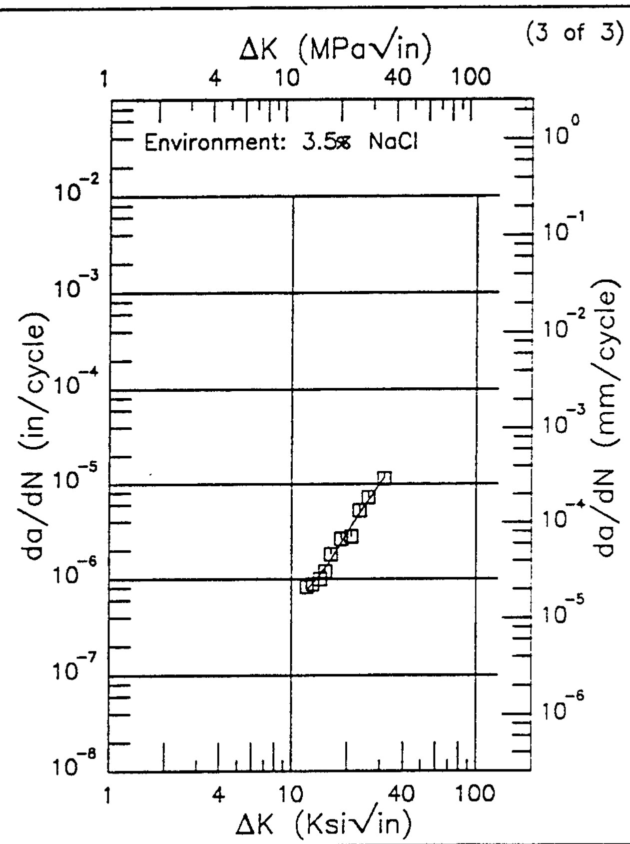
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.06 (min)	0.433
16.	1.15
20.	2.78
25.	5.33
30.	9.09
32.59 (max)	9.82

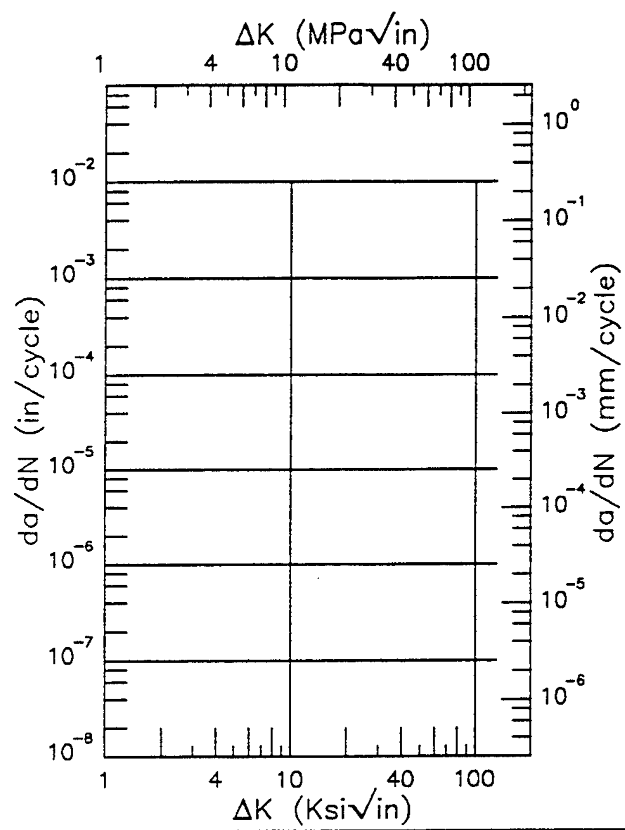
RMS % Error	Life Prediction Ratio Summary
15.18	0. .5 .8 1.25 2.

Figure 3.35.3.1.22

Condition/Ht:	Yield Strength:
Form: 0.63 in. Plate	Ult. Strength:
Specimen Type: DCB	Specimen Thk:
Orientation: T-L	Specimen Width:
Stress Ratio: 0.	Ref: 88140
Frequency: 15 Hz	

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.13 (min)	0.768
13.	0.880
16.	1.50
20.	3.02
25.	6.14
30.	10.2
31.67 (max)	11.6

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
10.14	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.35.3.1.22 (Concluded)

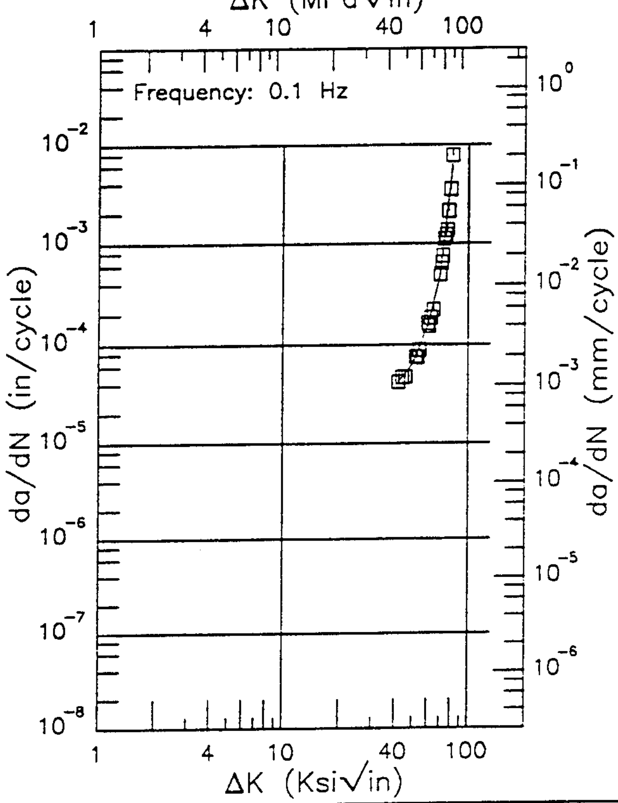
HP9-4-.30

F

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.1
Environment: WATER SAT JP4; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(1 of 2)



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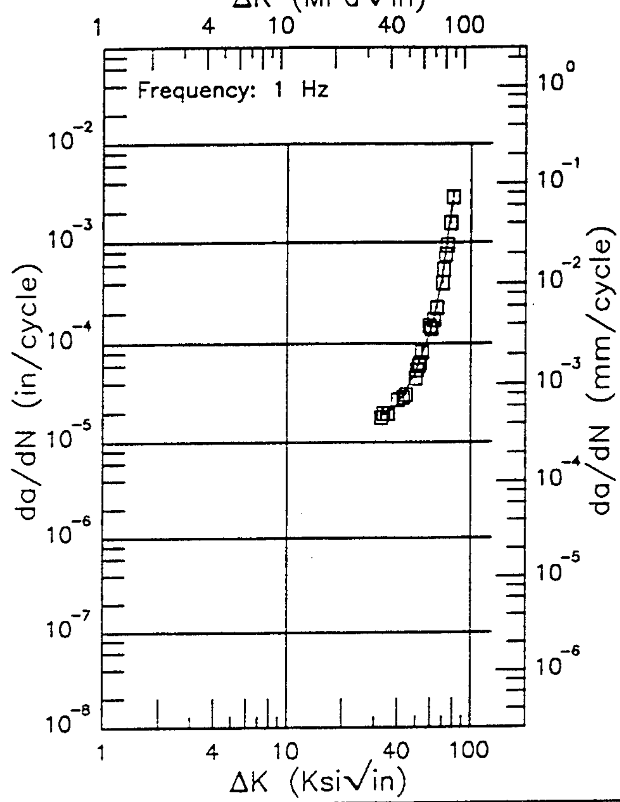


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
42.02 (min)	42.2
50.	64.0
60.	152.
70.	476.
80.	4201.
81.35 (max)	6309.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
32.39 (min)	18.9
35.	19.6
40.	24.3
50.	51.7
60.	132.
70.	448.
79.89 (max)	2613.

RMS % Error	Life Prediction Ratio Summary
13.74	0. .5 .8 1.25 2.

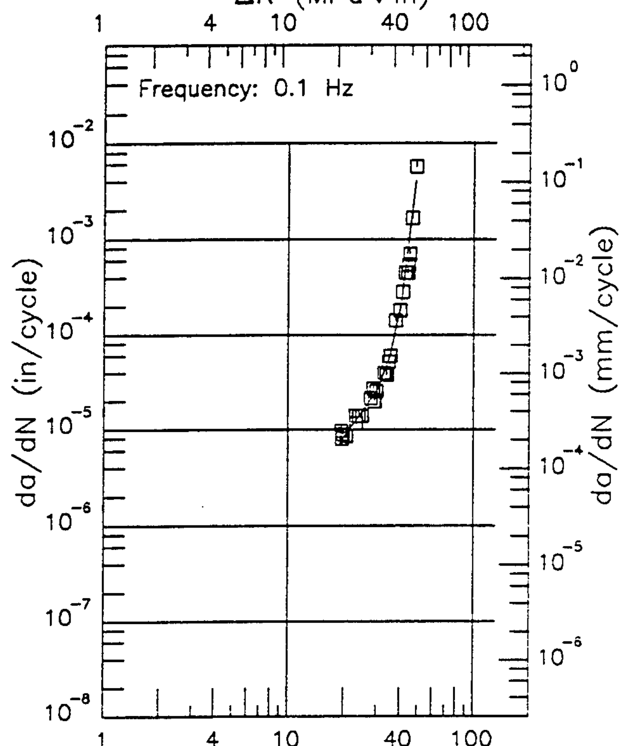
RMS % Error	Life Prediction Ratio Summary
8.48	0. .5 .8 1.25 2.

Figure 3.35.3.1.23

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T–L
Stress Ratio: 0.5
Environment: WATER SAT JP4; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(1 of 2)



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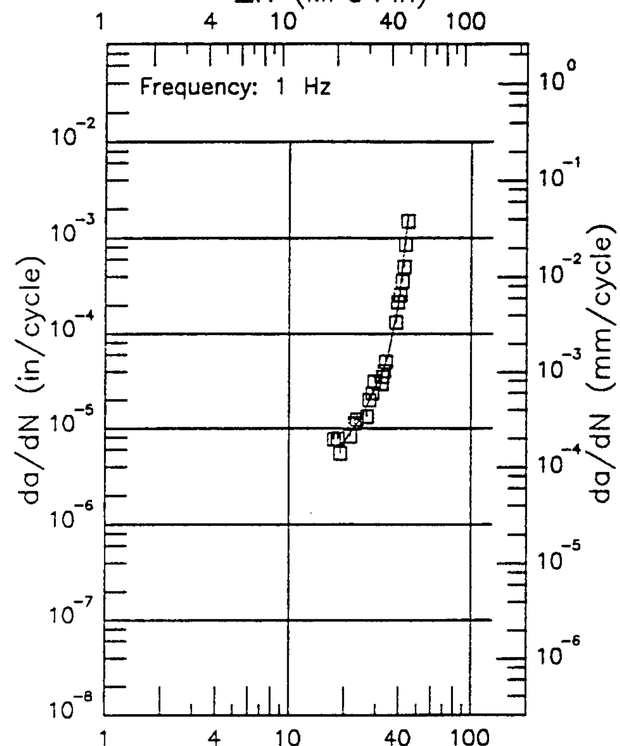


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.18 (min)	7.07
20.	8.46
25.	15.5
30.	25.4
35.	57.1
40.	195.
48.48 (max)	4021.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.61 (min)	6.24
20.	7.29
25.	13.2
30.	27.0
35.	59.0
40.	214.
44.83 (max)	1646.

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
20.87	0. .5 .8 1.25 2.	14.78	0. .5 .8 1.25 2.

Figure 3.35.3.1.24

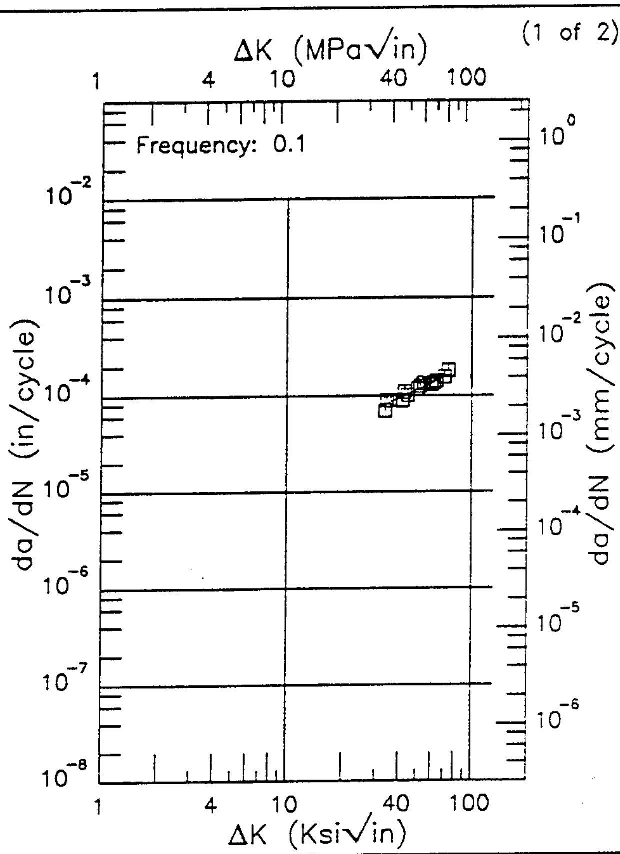
HP9-4-.30

F

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.1
Environment: 3.5% NACL; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

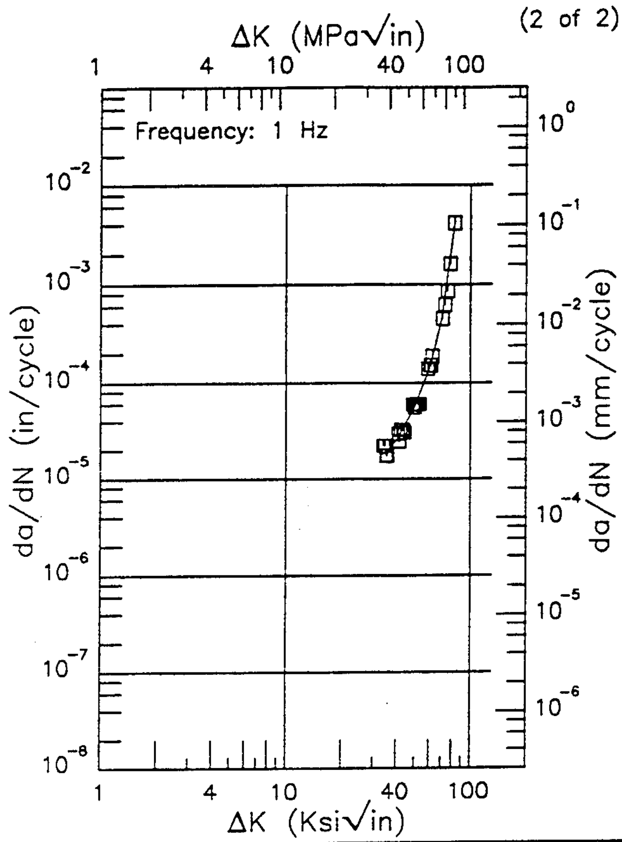
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.47 (min)	81.3
35.	84.1
40.	93.6
50.	114.
60.	135.
70.	156.
74.38 (max)	165.

RMS % Error	Life Prediction Ratio Summary
6.96	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.69 (min)	18.2
35.	19.0
40.	25.0
50.	56.5
60.	139.
70.	430.
80.	2669.
81.70 (max)	3963.

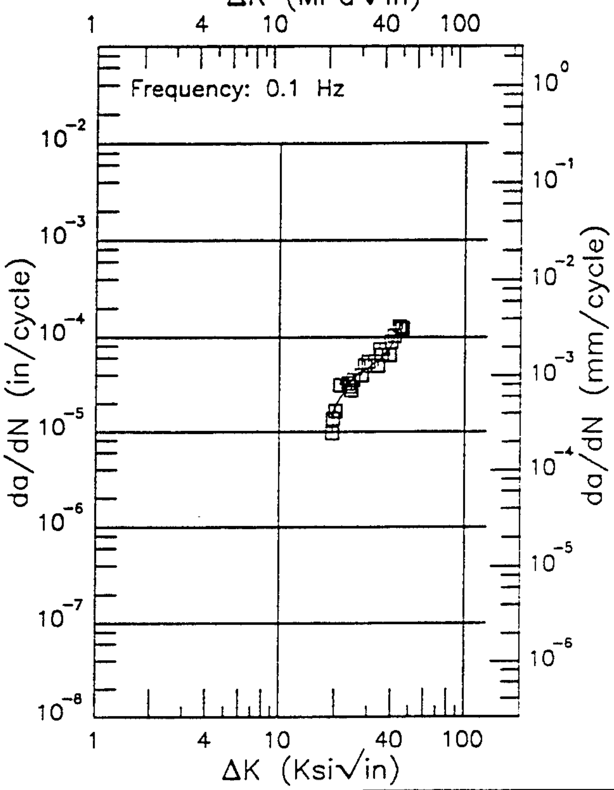
RMS % Error	Life Prediction Ratio Summary
11.84	0. .5 .8 1.25 2.

Figure 3.35.3.1.25

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.5
Environment: 3.5% NACL; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(1 of 2)



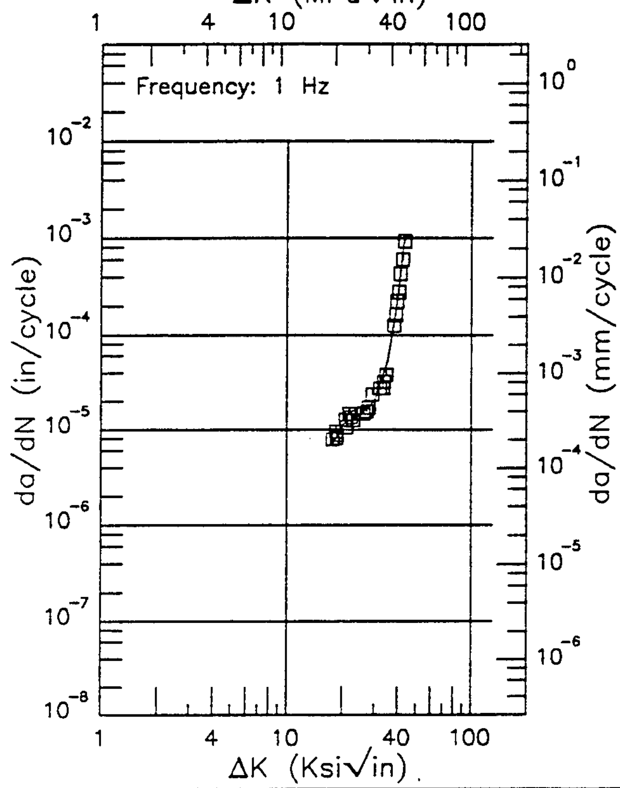
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.21 (min)	15.1
20.	18.7
25.	37.6
30.	48.0
35.	59.1
40.	82.0
45.63 (max)	145.

RMS % Error: 17.50

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.66 (min)	7.08
20.	11.3
25.	14.4
30.	20.4
35.	51.2
40.	251.
43.14 (max)	946.

RMS % Error: 11.87

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 3.35.3.1.26

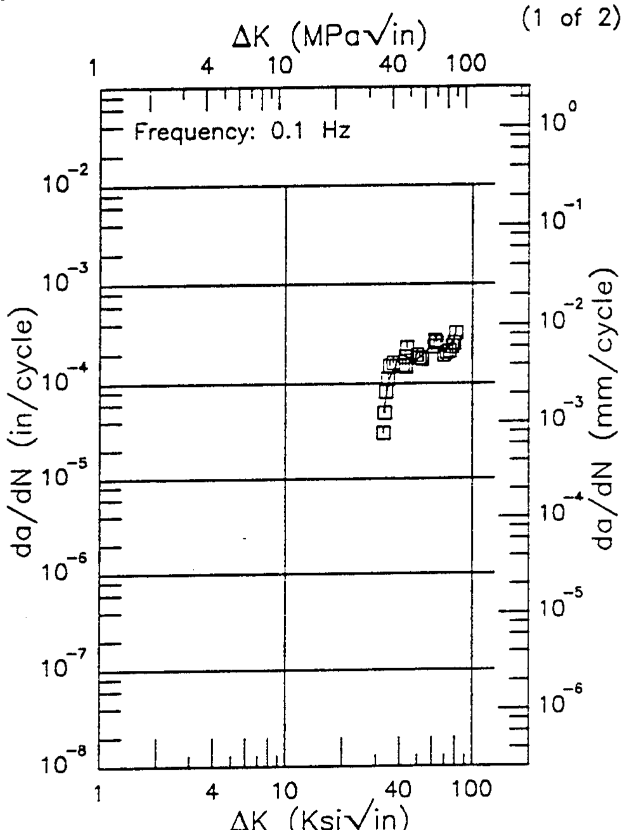
F

HP9-4-.30

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.1
Environment: S.T.W.; RT

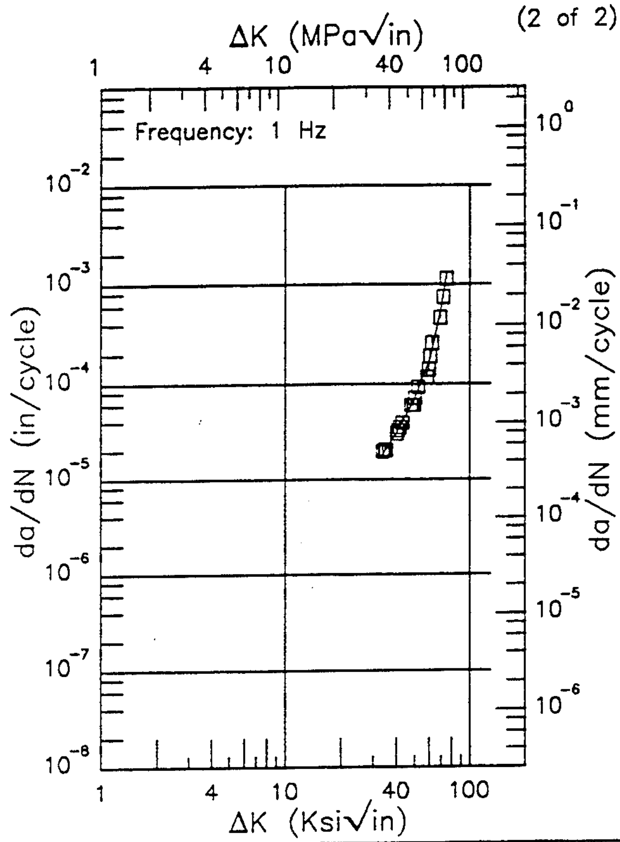
Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140

(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
32.86 (min)	50.1
35.	107.
40.	193.
50.	173.
60.	237.
70.	206.
80.	295.
80.85 (max)	330.

(2 of 2)



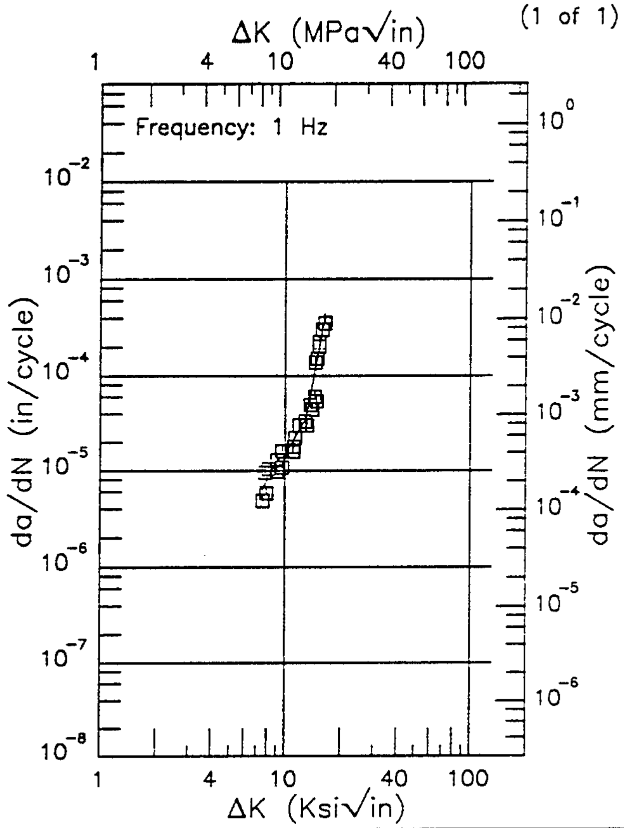
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.79 (min)	18.3
35.	20.3
40.	30.4
50.	68.8
60.	168.
70.	567.
74.63 (max)	1179.

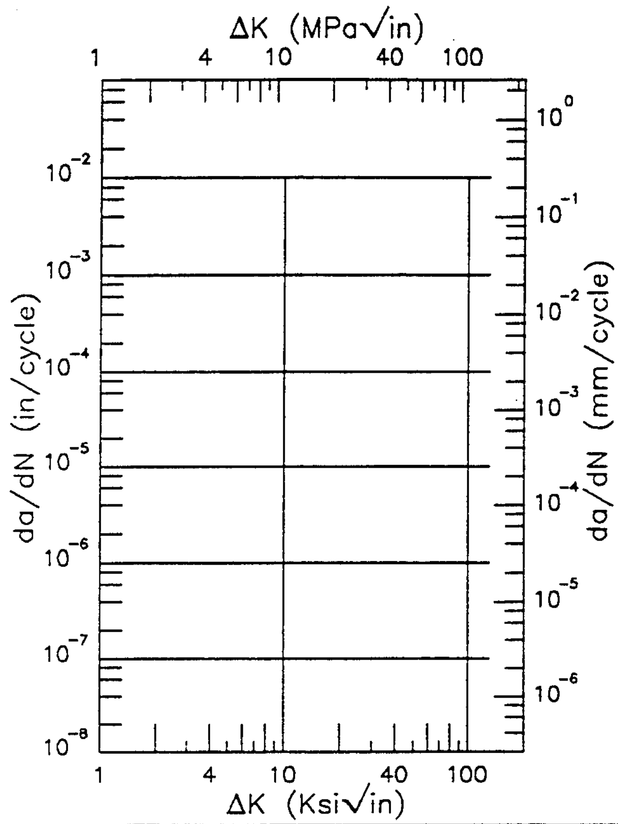
RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
17.07	0. .5 .8 1.25 2.	8.34	0. .5 .8 1.25 2.

Figure 3.35.3.1.27

Condition/Ht:
Form: 0.63 in. Plate
Specimen Type: DCB
Orientation: T-L
Stress Ratio: 0.8
Environment: DRY AIR; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: 88140





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.57 (min)	6.44
8.	8.55
9.	12.3
10.	14.9
13.	35.6
16.	336.
16.27 (max)	444.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
24.30	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

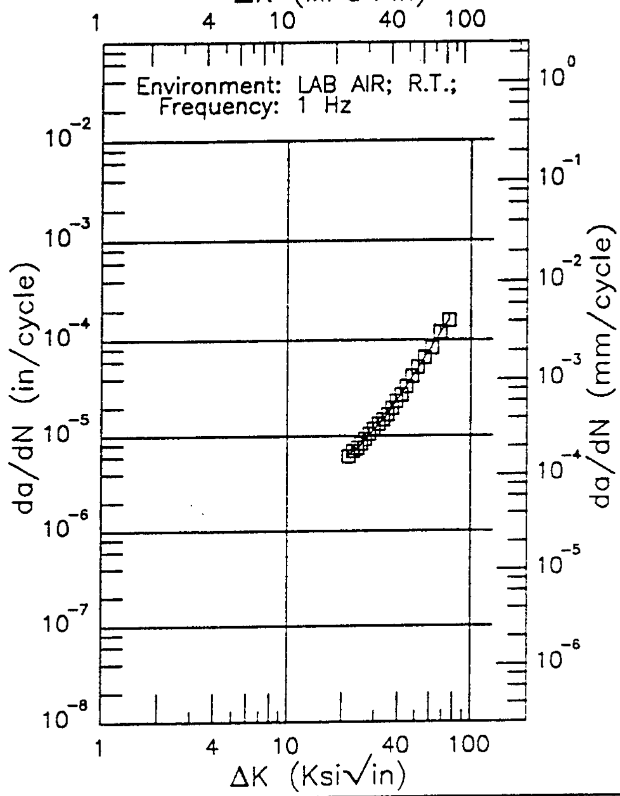
Figure 3.35.3.1.28

EF HP9-4-.30

Condition/Ht:
Form: 2.5 in. Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.02

Yield Strength: 192.5 ksi
Ult. Strength: 228 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: 88136

(1 of 3)



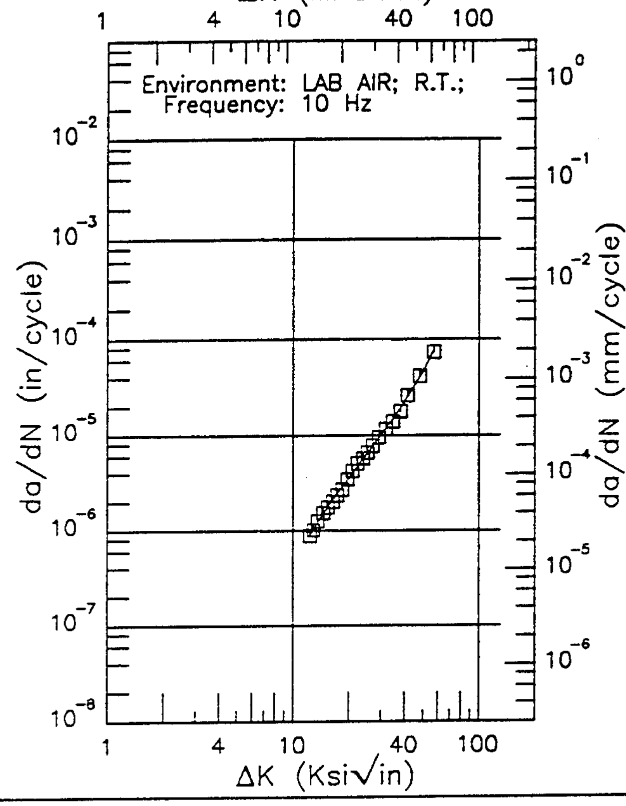
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
21.66 (min)	6.29
25.	7.96
30.	11.6
35.	17.0
40.	24.4
50.	46.4
60.	79.8
70.	126.
75.97 (max)	159.

RMS % Error 2.49

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.31 (min)	0.880
13.	1.05
16.	1.96
20.	3.59
25.	6.34
30.	10.1
35.	15.4
40.	22.6
50.	46.6
56.90 (max)	75.0

RMS % Error 3.83

Life Prediction Ratio Summary

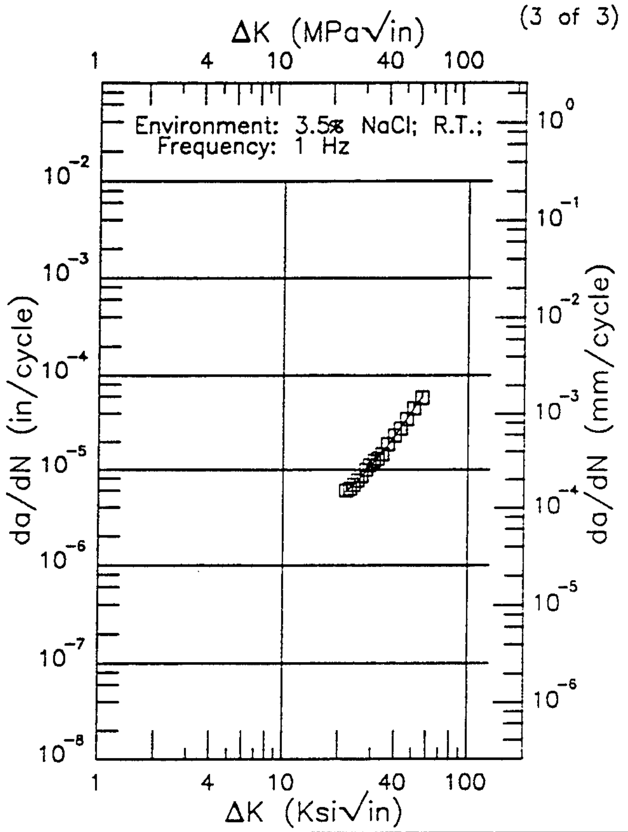
0. .5 .8 1.25 2.

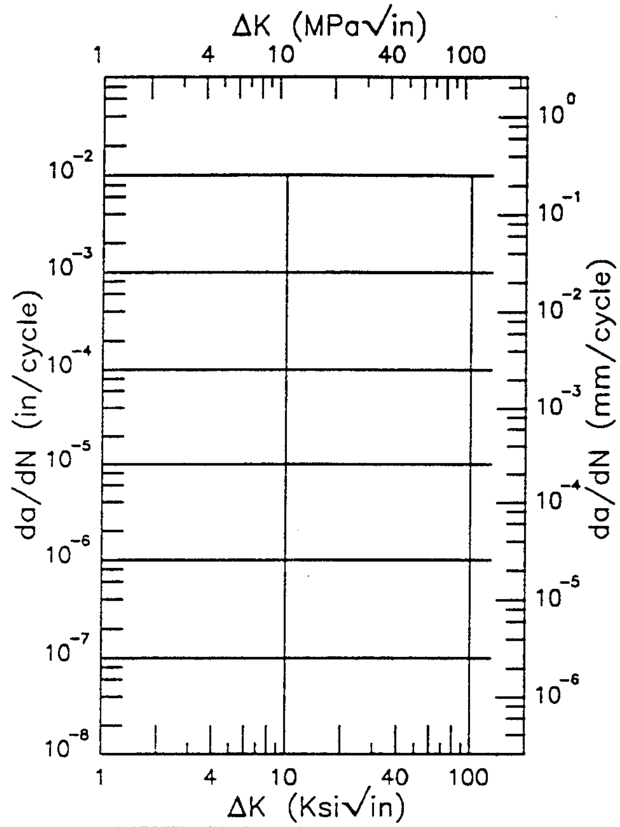
Figure 3.35.3.1.29

Condition/Ht:
Form: 2.5 in. Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.02

Yield Strength: 192.5 ksi
Ult. Strength: 228 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: 88136

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
21.78 (min)	5.82
25.	7.60
30.	11.3
35.	16.3
40.	22.9
50.	42.8
55.81 (max)	59.4

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error	Life Prediction Ratio Summary
2.46	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.35.3.1.29 (Concluded)

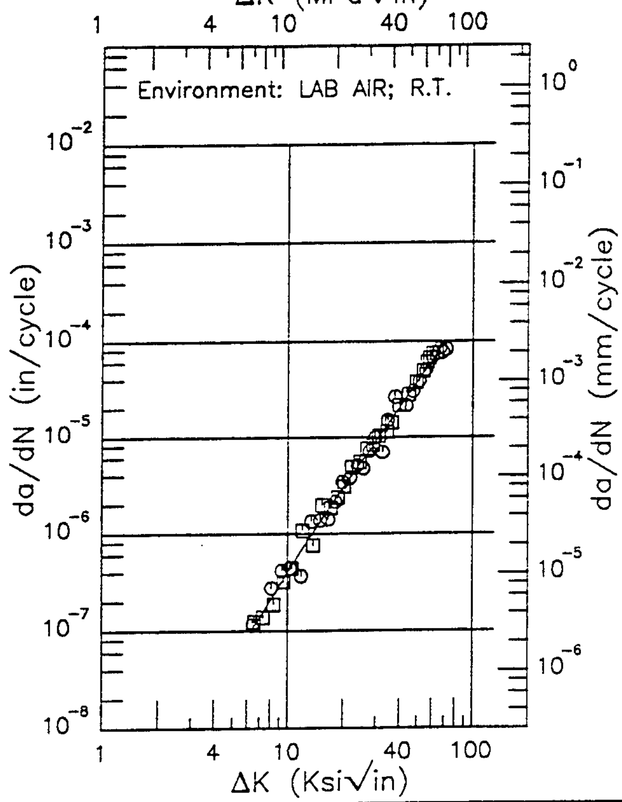
E

HP9-4-.30

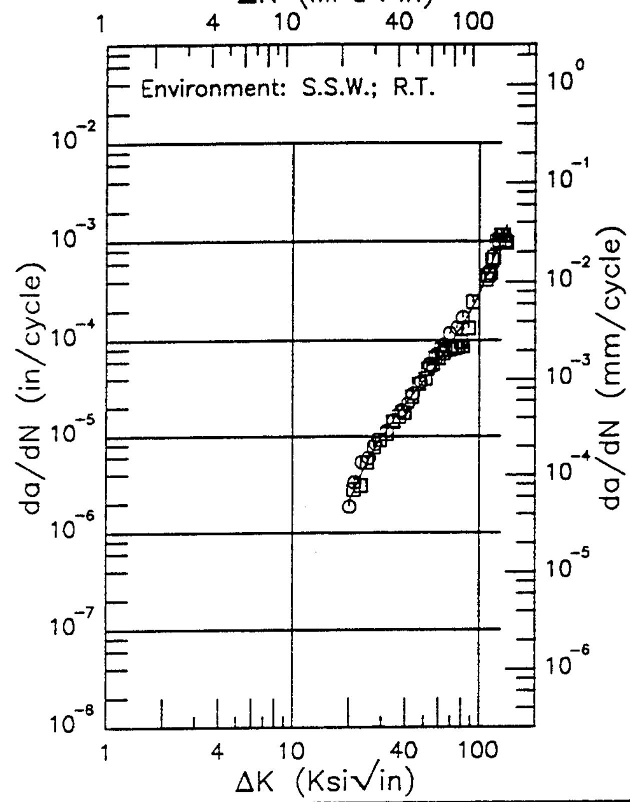
Condition/Ht:
Form: 1.25 in. Forging
Specimen Type: WOL
Orientation: L-T
Stress Ratio: 0.02
Frequency: 0.1 - 20 Hz

Yield Strength: 204.5 ksi
Ult. Strength: 230.5 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: MA005

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.38 (min)	0.102
7.	0.137
8.	0.207
9.	0.296
10.	0.406
13.	0.876
16.	1.59
20.	2.97
25.	5.52
30.	9.12
35.	13.9
40.	20.1
50.	37.4
60.	62.3
70.	96.3
71.24 (max)	101.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
20.13 (min)	2.17
25.	5.27
30.	9.73
35.	15.2
40.	21.7
50.	37.7
60.	59.7
70.	90.6
80.	135.
90.	201.
100.	298.
130.	984.
139.67 (max)	1451.

RMS % Error	Life Prediction Ratio Summary
19.58	0. .5 .8 1.25 2.

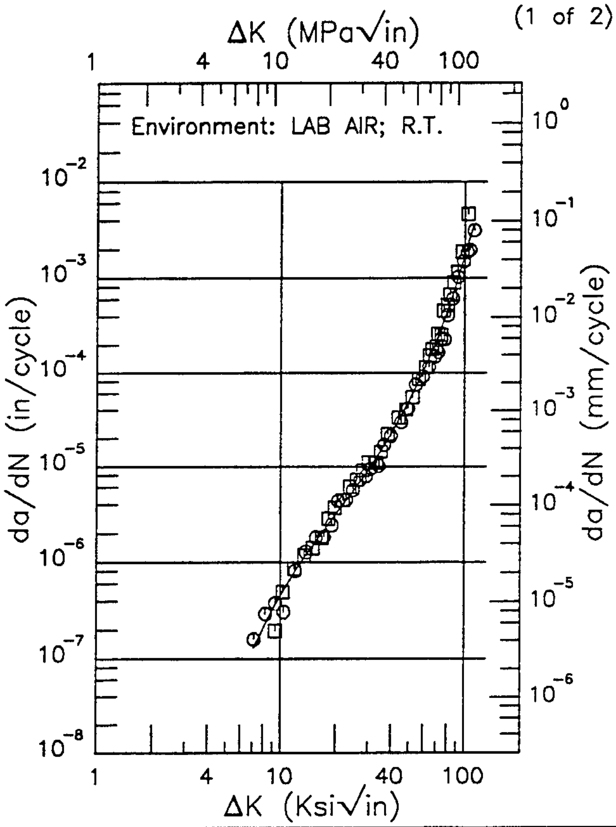
RMS % Error	Life Prediction Ratio Summary
16.46	0. .5 .8 1.25 2.

Figure 3.35.3.1.30

Condition/Ht:
Form: 1.25 in. Forging
Specimen Type: WOL
Orientation: T-L
Stress Ratio: 0.02
Frequency: 0.1 – 20 Hz

Yield Strength: 206 ksi
Ult. Strength: 233 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: MA005

(1 of 2)

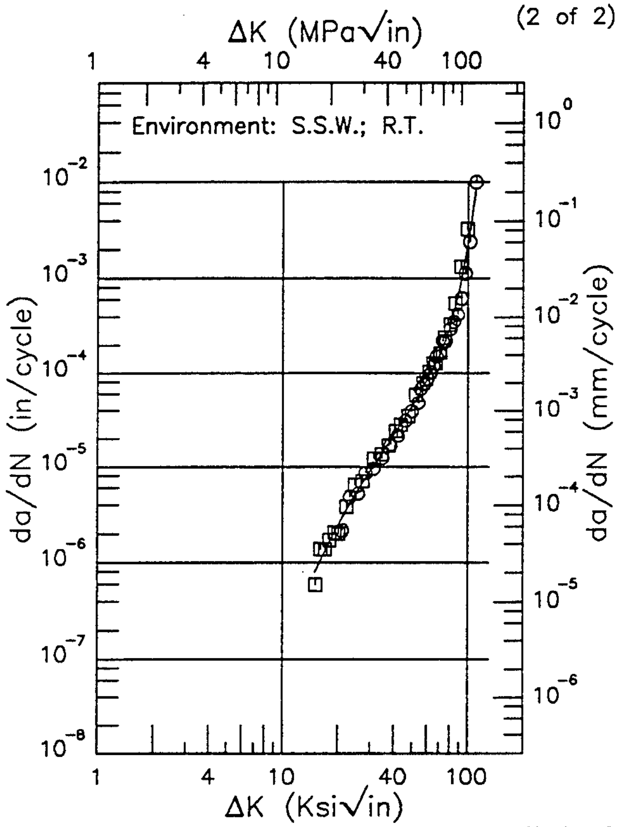


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.13 (min)	0.131
8.	0.207
9.	0.319
10.	0.456
13.	1.01
16.	1.77
20.	3.14
25.	5.59
30.	9.17
35.	14.4
40.	22.0
50.	49.1
60.	105.
70.	218.
80.	444.
100.	1733.
111.38 (max)	3654.

RMS % Error: 21.91

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.09 (min)	0.791
16.	1.02
20.	2.44
25.	5.20
30.	9.18
35.	14.6
40.	21.8
50.	44.1
60.	82.7
70.	152.
80.	307.
90.	749.
100.	2260.
110.08 (max)	8515.

RMS % Error: 17.77

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 3.35.3.1.31

TABLE 3.35.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL HP9-4-.30

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
Quenched + Tempered at 950°F	P	R.T.	---	---	3.5% NaCl	NB	1.5	0.5	0.48	0.3	116	35*	---	1967	74302
				200	3.5% NaCl	NB	1.5	0.48	0.48	---	116	45	---	1967	74302
Unspecified	F	R.T.	T-L	206	Sim. Sea Water	BWOL	3.085	1.251	1.25	1.36	---	<41.3	---	1977	MA005
						BWOL	3.087	1.25	1.25	1.38	---	<41.6	---	1977	MA005
			S-T	204.5	Sim. Sea Water	BWOL	3.079	1.251	1.25	1.37	---	<38.6	---	1977	MA005
						BWOL	3.079	1.25	1.25	1.36	---	<38.5	---	1977	MA005

* specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 3.36.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL HP9-4-.45

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1600°F 0.5hr AC; 1500°F 0.33hr AC	S	R.T.	---	212.5	3N NaCl	CNT	2	0.05	0.08	---	---	35*	30000	1968	72283
					Dist. Water	CNT	2	0.05	0.08	---	---	88*	20000	1968	72283
475°F	P	R.T.	---	220	3.5% NaCl	NB	1.5	0.48	0.48	0.3	89	20	---	1971	84351

* specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 3.37.3.3

K_{Iscc} SUMMARY FOR ALLOY STEEL HY-150

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1500°F 1hr WQ	P	R.T.	---	150	3.0% NaCl	CANT*	2	1	1	0.2	---	115⁺	30000	1968	73824

⁺ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 3.38.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HY-180 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

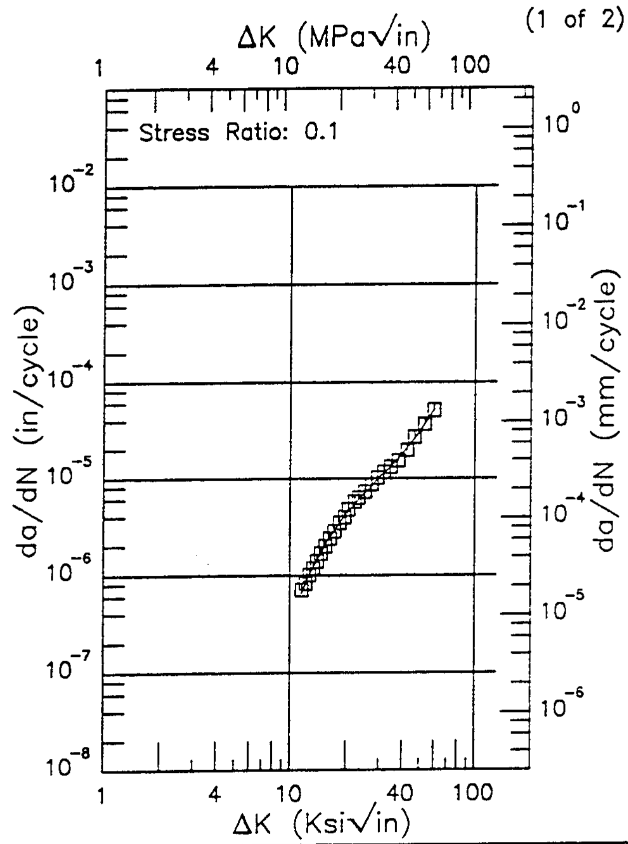
CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
STA (UTS=180KSI)	FORGED BAR	0.1	10				4.29	30.82	
		0.1	30		0.11	0.48	3.72		
		0.5	10				5.61		
		0.5	30		0.11	0.53	4.5		

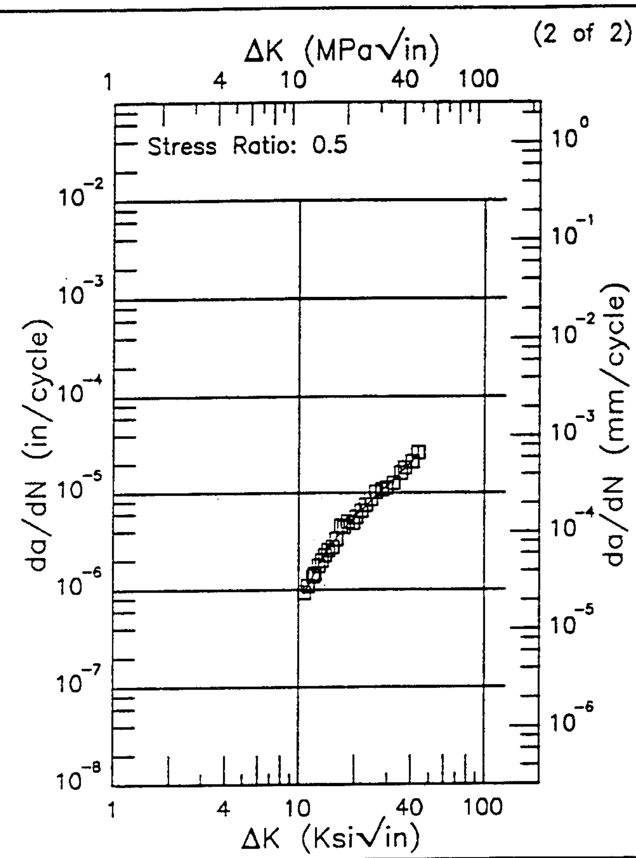
HY-180

R

Condition/Ht: STA (UTS=180KSI)
Form: 1.75 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 10 Hz
Environment: LAB AIR; RT

Yield Strength: 197.1 ksi
Ult. Strength: 199.6 ksi
Specimen Thk: 0.377 in.
Specimen Width: 1.5 - 1.501 in.
Ref: DA001



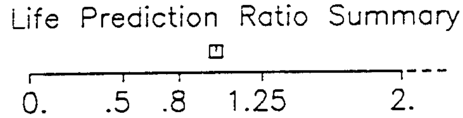


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.51 (min)	0.645
13.	1.10
16.	2.31
20.	4.29
25.	7.04
30.	10.1
35.	13.6
40.	18.0
50.	30.8
59.28 (max)	51.3

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.71 (min)	0.899
13.	1.84
16.	3.37
20.	5.61
25.	8.57
30.	11.9
35.	15.8
40.	20.6
43.61 (max)	25.0

RMS % Error
3.54

Life Prediction Ratio Summary



RMS % Error
5.54

Life Prediction Ratio Summary

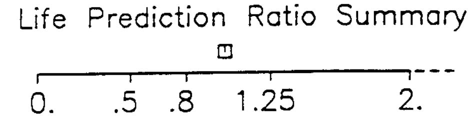
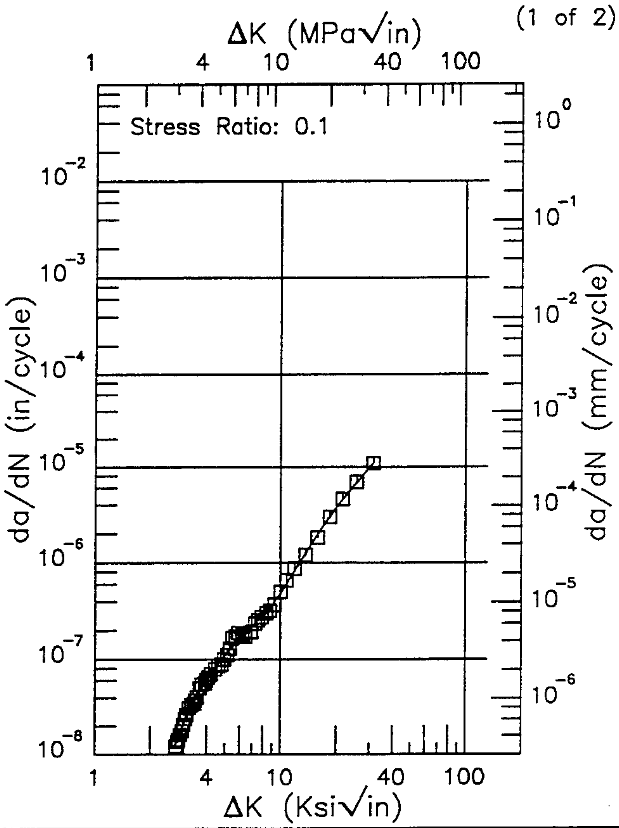


Figure 3.38.3.1.1

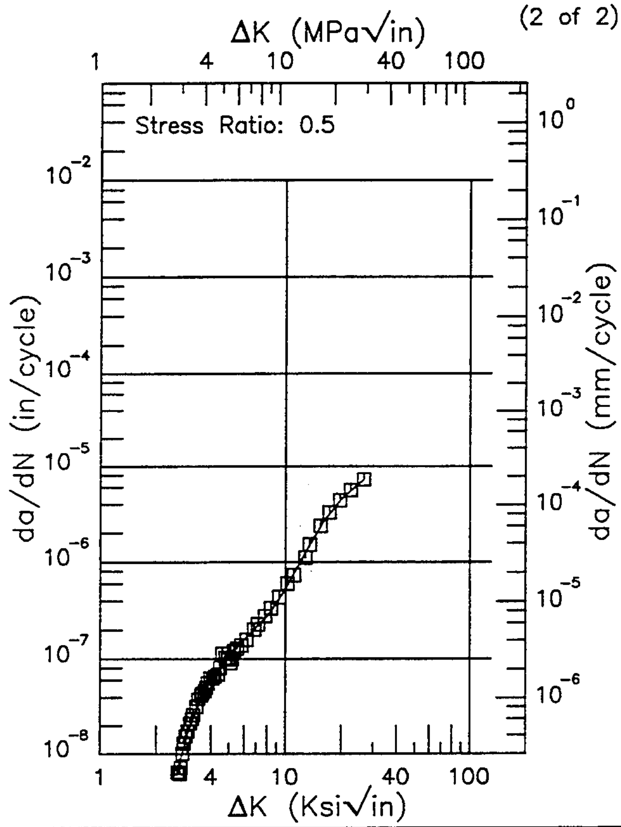
Condition/Ht: STA (UTS=180KSI)
Form: 1.75 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 30 Hz
Environment: LAB AIR; RT

Yield Strength: 197.1 ksi
Ult. Strength: 199.6 ksi
Specimen Thk: 0.253 in.
Specimen Width: 1.5 in.
Ref: DA001

(1 of 2)



(2 of 2)

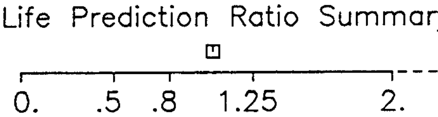


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
2.72 (min)	0.0126
3.	0.0207
3.5	0.0395
4.	0.0619
5.	0.111
6.	0.162
7.	0.217
8.	0.284
9.	0.368
10.	0.479
13.	1.06
16.	2.02
20.	3.72
25.	6.54
30.	10.0
31.28 (max)	10.8

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
2.62 (min)	0.00670
3.	0.0167
3.5	0.0367
4.	0.0611
5.	0.111
6.	0.158
7.	0.211
8.	0.280
9.	0.381
10.	0.529
13.	1.32
16.	2.58
20.	4.50
25.	6.50
26.38 (max)	7.18

RMS % Error 7.54

Life Prediction Ratio Summary



RMS % Error 10.67

Life Prediction Ratio Summary

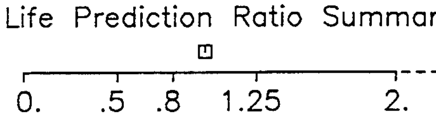


Figure 3.38.3.1.2

TABLE 3.39.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK HY-80 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
UNSPECIFIED	UNSPECIFIED	0.1	0.5					28.1	

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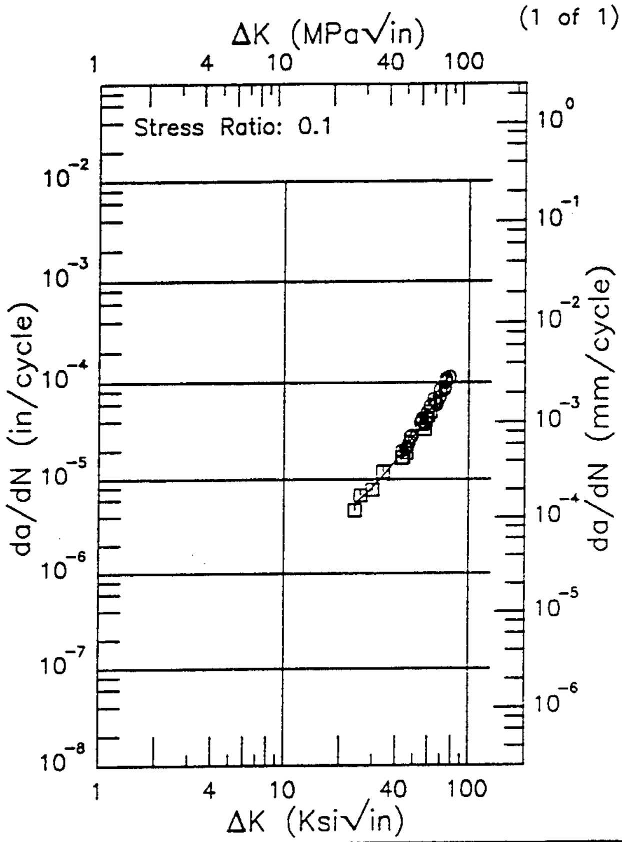
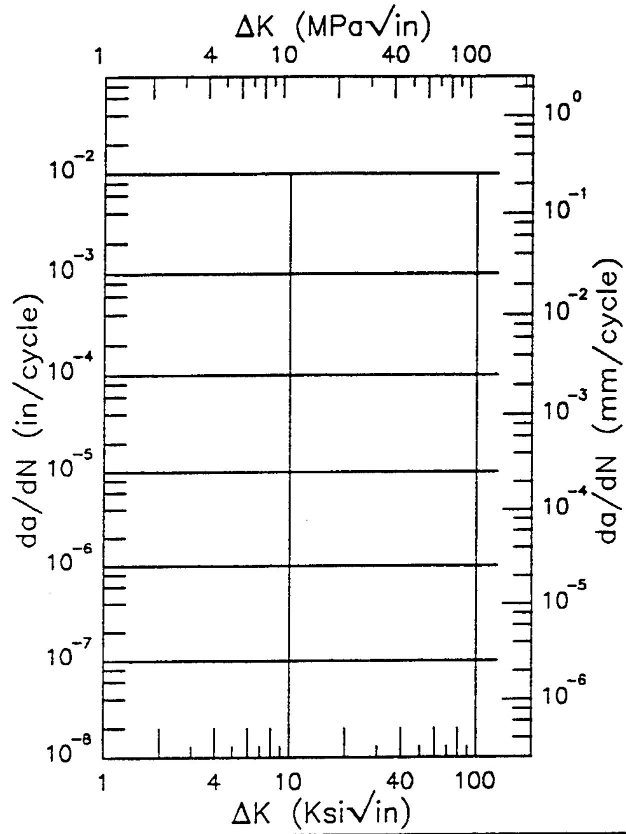
R

HY-80

Condition/Ht:	Yield Strength:
Form:	Ult. Strength:
Specimen Type: WOL	Specimen Thk: 0.4 in.
Orientation:	Specimen Width: 2.55 in.
Frequency: 0.5 Hz	Ref: UD007
Environment: 3.5% NACL; RT	

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
24.02 (min)	5.47
25.	5.88
30.	8.35
35.	11.6
40.	15.8
50.	28.1
60.	48.0
70.	79.2
77.74 (max)	114.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
9.21	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 3.39.3.1

TABLE 3.40.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR ALLOY STEEL HY-TUF AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1700F 1HR AC 1600F 1HR OQ 550F 2HR	---	---	---	111.5	2.1	2	---	---	---

TABLE 3.40.2.1

ALLOY STEEL HY-TUF K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1700F 1HR AC 1600F 1HR OQ 550F 2HR	Forging	6.50	R.T.	L-T	198.0	1.999	1.000	CT	0.983	0.86	116.00	---	---	1974	91284
1700F 1HR AC 1600F 1HR OQ 550F 2HR	Forging	6.50	R.T.	T-L	198.0	1.999	1.003	CT	0.977	0.76	110.00	111.5	2.1	1974	91284
		6.50			198.0	1.999	1.003	CT	0.973	0.81	113.00			1974	91284
1700F 1HR AC 1600F 1HR + 1000F 20 MIN	Forging	6.50	R.T.	L-T	198.0	1.999	1.003	CT	0.988	0.92	120.00	---	---	1974	91284
1700F 1HR AC 1600F 1HR + 1000F 20 MIN	Forging	6.50	R.T.	T-L	200.0	1.999	1.003	CT	0.977	0.80	113.00	---	---	1974	91284

TABLE 3.41

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60578	18Ni(300)(MAR)	K_c

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63061	18Ni(300)(MAR)	K_{Iscc}
	4140	K_{Iscc}
	4340	K_{Iscc}
	D6AC	K_{Iscc}

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65166	12Ni-5Cr-3Mo	K_{Iscc}
	18Ni(180)(MAR)	K_{Iscc}
	18Ni(250)(MAR)	K_{Iscc}

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69162	18Ni(200)(MAR)	K_{Iscc}

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70887	12Ni-5Cr-3Mo	K_{Iscc}
	18Ni(200)(MAR)	K_{Iscc}
	18Ni(250)	da/dt
	4340	da/dt; K_{Iscc}

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72283	18Ni(250)(MAR)	K_{Iscc}
	4340	K_{Iscc}
	D6AC	K_{Iscc}
	H11	K_{Iscc}
	HP9-4-.45	K_{Iscc}

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73300	300M (AM)	K_{Ic}
	300M (VAR)	K_{Ic}
	4340 (AM)	K_{Ic}
	4340 (DH)	K_{Ic}
	4340 (VAR)	K_{Ic}

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73612	18Ni(250)(MAR)	K_{Ic}

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73824	HY-150	K_{Iscc}

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73829	18Ni(250)(MAR)	K_{Iscc}

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73988	300M	K_c

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74232	12Ni-5Cr-3Mo	K_{Iscc}
	18Ni(250)(MAR)	K_{Iscc}
	HP9-4-.20	K_{Iscc}

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74302	300M	K_{Iscc}
	HP9-4-.30	K_{Iscc}

Carter, C. S., "Crack Extension in Several High-Strength Steels Loaded in 3.5% Sodium Chloride Solution", Research Report D6-19770, The Boeing Company, Renton, Wash., ARPA Contract N00014-66-C-0365 (November 1967).

74718	300M	K_{Iscc}
	4340	da/dt; K_{Iscc}
	4340 (MOD)	K_{Iscc}

Carter, C. S., "The Effect of Silicon on the Stress Corrosion Resistance of Low-Alloy, High-Strength Steels", Research Report D6-23872, The Boeing Company, Renton, Wash., ARPA Contract N00014-66-C-0365 (March 1965).

74719	18Ni(300)	da/dt
	18Ni(350)	da/dt

Carter, C. S., "Stress Corrosion Crack Branching in High-Strength Steels", Research Report D6-23781, The Boeing Company, Renton, Wash., ARPA Contract N00014-66-C-0365 (March 1965).

75025	4340	K_{Iscc}

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75111	H11	da/dt

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75677	18Ni(350)(MAR)	K_{Iscc}

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76411	18Ni(200)(MAR)	K_{Ic}
	HP9-4-.25(VAR)	K_{Ic}

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76972	4340 4340V	K_{Iscc} da/dt

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77716	18Ni(300)(MAR)	K_{Iscc}

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78065	18Ni(250)(MAR)	K_{Iscc}

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78305	300M 300M (VM)	K_{Ic}; K_{Iscc} K_{Ic}

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78313	18Ni(250) 300M	da/dt da/dt

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78425	18Ni(300)(MAR)	K_{Ic}; da/dN; K_{Iscc}

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78761	18Ni(300)(MAR) 4340	K_{Iscc} K_{Iscc}

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80423	4340 4340 (MOD)	K_{Iscc} K_{Iscc}

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80667	18Ni(200)(MAR) HP9-4-.20	K_{Iscc} K_{Iscc}

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80824	18Ni(200)(MAR) 18Ni(250)(MAR)	K_{Iscc} K_{Iscc}

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81004	18Ni(180)(MAR) 18Ni(200)(MAR)	K_{Iscc} K_{Iscc}

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81814	4340	da/dt; K_{Iscc}

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82164	18Ni(280)(MAR)	K_{Iscc}

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82543	D6AC	K_{Ic}; a-vs-N; da/dN

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83611	4340 (EFM)	da/dt

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83613	12Ni-5Cr-3Mo	K_{Iscc}
	18Ni(180)(MAR)	K_{Iscc}
	18Ni(200)(MAR)	K_{Iscc}
	18Ni(250)(MAR)	K_{Iscc}
	HP9-4-.20	K_{Iscc}

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83834	18Ni(200)(MAR)	K_{Ic}
	18Ni(250)(MAR)	K_{Ic}

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84029	300M	K_{Ic}
	4330V (MOD)	K_{Ic}
	4340	K_{Ic}
	D6AC	K_{Ic}
	HP9-4-.30	K_{Ic}

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84277	4330V (MOD)	K_{Ic}
	4340	K_{Ic}
	D6AC	K_{Ic}

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84278	300M (VM)	K_{Ic}

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84280	300M	K_{Ic}
	4340 (DH)	K_{Ic}

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84290	4340	K_{Iscc}

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84306	HP9-4-.20	K_{Ic}
	HP9-4-.30	K_{Ic}

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84309	4340	da/dt
	H11	da/dt

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84310	18Ni(250)	da/dt
	18Ni(300)	da/dt
	4340	da/dt

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84313	4340	da/dt

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84317	12Ni-5Cr-3Mo	K_{Iscc}

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	18Ni(200)(MAR)	K_{Iscc}

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84351	18Ni(250)(MAR)	K_{Iscc}
	18Ni(350)(MAR)	K_{Iscc}
	300M	K_{Iscc}
	4330V	K_{Iscc}
	H11	K_{Iscc}
	HP9-4-.45	K_{Iscc}

Carter, C. S., "Stress Corrosion Crack Branching in High Strength Steels", Engineering Fracture Mechanics, 3, p 1-13 (July 1971).

84356	18Ni(300)(MAR)	K_{Iscc}
	4340	K_{Iscc}

Carter, C. S., "Effect of Prestressing on the Stress Corrosion Resistance of Two High-Strength Steels", Metallurgical Trans., 3, p 584-587 (February 1972).

84963	4140	K_{Iscc}

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85545	300M	da/dt

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85633	HP9-4-.20	K_{Ic}

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85836	300M	K_{Ic}
	HP9-4-.20	K_{Ic}

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TABLE 3.41 (CONTINUED)

85837 HP9-4-.20 a-vs-N; da/dN
HP9-4-.30 a-vs-N; da/dN

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85857 HP9-4-.20 K_{Ic}

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85879 HP9-4-.20 K_{Ic}

"Fracture Toughness Data - Shultz Steel Company - May 15, 1973", per memo from Ed Cawthorne of May 15, 1973.

85883 300M K_{Ic}
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86428 HP9-4-.20 K_{Ic}

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86582 18Ni(300)(MAR) K_{Ic}
4340 K_{Ic}

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87241 300M K_{Ic}
4140 K_{Ic}
4330V (MOD) K_{Ic}
4340 K_{Ic}

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88136 | 300M | K_{Ic}
| HP9-4-.20 | K_{Ic}; a-vs-N; da/dN
| HP9-4-.30 | K_{Ic}; a-vs-N; da/dN

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88140 | HP9-4-.30 | da/dN

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88575 | 10NI STEEL | a-vs-N; da/dN

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88579 | HP9-4-.20 | a-vs-N; da/dN
| HP9-4-.30 | a-vs-N; da/dN

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89311 | 4340 | da/dN

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90011 | HP9-4-.20 | K_{Ic}
| HP9-4-.30 | K_{Ic}

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90012 | HP9-4-.20 | K_{Ic}

"Ti-6Al-4V Fracture Toughness Data - Shultz Steel Company, South Gate, CA, of August 8, 1974", with memorandum from E. W. Cawthorne to H. D. Moran of Battelle's Columbus Laboratories (August 8, 1974).

90981	18Ni(250)(MAR)	K_{Ic}

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91284	HY-TUF	K_{Ic}

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91838	18Ni(300)(MAR)	da/dN

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AM002	HP9-4-.30	K_{Ic}

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BW001	4340	da/dN

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BW002	4340	da/dN

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DA001	12-9-2 (MAR)	K_{Ic}; da/dN
	12-9-2 MAR	a-vs-N
	4340	K_{Ic}; a-vs-N; da/dN
	H11	a-vs-N; da/dN
	HY-180	a-vs-N; da/dN

Fatigue Crack Growth Rate Data Sheets on Aluminum Alloys 2024, 7010, 7050, 7075 and 7475, Stainless Steel Alloys 17-4PH and 17-7PH, and Alloy Steels 4340, A286, H-11, HY-180 and 12-9-2, Sent from Mr. Paul Abelkis, Douglas Aircraft Company, McDonnell Douglas Corporation, Long Beach, CA, March 1982.

TABLE 3.41 (CONTINUED)

HD006	A286	a-vs-N; da/dN

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MA004	AF1410	a-vs-N; da/dN

Fatigue Crack Growth Rate Data on AF1410 Steel in Bar Form, McDonnell Aircraft Company, St. Louis, MO, Data Submitted by D. L. Rich, Attachment #4, received March 12, 1982.

MA005	300M	K_{Ic}; da/dN; K_{Iscc}
	HP9-4-.20	K_{Ic}; da/dN; K_{Iscc}
	HP9-4-.30	K_{Ic}; da/dN; K_{Iscc}

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MA006	300M	da/dN

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MA007	300M	da/dN
	HP9-4-.30	da/dN

Garland, K., and Krieg, J. F., "Environment-Load Interaction Effects on Crack Growth", McDonnell Aircracft Company, St. Louis, MO, Report No. 703-116, June 1978.

MA010	300M	da/dN
	HP9-4-.30	da/dN

Garland, K., and Krieg, J. F., "Environment-Load Interaction Effects on Crack Growth in Landing Gear Steels", McDonnell Aircraft Company, St. Louis, MO, Report No. TR 703-535, TM 256-6627, February 1981.

MA011	4330V (MOD)	K_{Ic}; da/dN

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MA012	4340	da/dN

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MA018	AF1410	K_{Ic}

Data submitted by Mr. Eric Tuegel, McDonnel Aircraft Co., 253.09.0227.01, October 1990.

MD001	D6AC	K_{Ic}

Davis, R. J., and Rowe, R. A., "Mechanical Properties of SRB Rolled-Ring Forgings and Large Hand Forgings", McDonnell Douglas Astronautics Company, Huntington Beach, CA, Report MDC G8545, June 1980.

MR002	4140	K_{Ic}
	4340	K_{Ic}

"Damage Tolerant Test Data on 4140 and 4340 Steel", Materials Research Laboratory, Inc., Glenwood, IL, Under Contract to ARRAD COM (DAAKIO-79-C-0358), November 1980.

NC001	HP9-4-.20	K_{Ic}

Plane Strain Fracture Toughness Data Sets on Aluminum, Steel, and Titanium Alloys, Data sent from P. G. Porter of Northrop Corporation, March 1, 1982.

NC002	HP9-4-.20(CEVM)	a-vs-N; da/dN

Fatigue Crack Growth Rate Data on Aluminum, Steel, and Titanium Alloys, Data sent from P. G. Porter of Northrop Corporation, March 1, 1982.

RI001	AF1410	K_{Ic}
	AF1410(VIM-VAR)	a-vs-N; da/dN

Routh, W. E., "Lower Cost by Substituting Steel for Titanium", Rockwell International Corporation, Los Angeles, CA, Contract No. F33615-75-C-3109, Report No. AFFDL-TR-77-73, June 1977.

RI006	300M	da/dN; K_{Iscc}
	HP9-4-.20	K_{Iscc}

Ferguson, R. R., and Berryman, R. C., "Fracture Mechanics Evaluation of B-1 Materials", Rockwell International, B-1 Division, Los Angeles, CA, Contract No. F33657-70-C-0800, Report No. AFML-TR-76-137, October 1976.

TABLE 3.41 (CONCLUDED)

RI011	AF1410	a-vs-N; da/dN
	Demonet, R. J., Newland, J. C., and Diaz, J. H., "Cyclic Crack Growth Rate Testing of AF 1410 Steel - Phase II", Rockwell International, LTR 2296-4166, August 1977.	
SW001	4340	a-vs-N; da/dN
	Data submitted by Mr. Jack Fitzgerald, Southwest Research Institute, San Antonio, TX.	
UD007	HY-80	da/dN
	Ruschau, J. J., "Navy Round Robin Corrosion Fatigue Crack Growth Rate Test Results for HY-80", University of Dayton Research Institute, Dayton, OH, Contract No. F33615-80-C-5011, Technical Memorandum UDR-TM-81-37, November 1981.	
WL005	4340	a-vs-N; da/dN
	Data submitted by Mr. Jim Harter from ASTM round robin, Wright-Patterson Materials Lab, April 1992.	

CHAPTER 4
STAINLESS STEEL SECTIONS

TABLE 4.0.1

AVAILABLE DATA FOR STAINLESS STEEL ALLOYS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
15-5PH	H900	Rolled Bar	10					
		Bar						3
	H1025	Forging	12			22		
		Rolled Bar	2					
		Bar				7		
	H1100	Rolled Bar	3					
	H1150M	Bar						3
	TUS=150-165KSI	Billet				8		
	TYS=150-165KSI	Forging	3					
15-5PH(AM)	H900	Forging						1
	H1000	Forging						1
15-5PH(VM)	H900	Forging						1
	H1000	Forging						1
17-4PH	H900	Plate				2		
		Bar						1
	H975	Rolled Bar	1					
	H1000	Bar						1
	H1025	Casting				2		
		Round Bar	1			4		
17-7PH	RH950	Bar						1
	RH1050	Rolled Bar	3					
		Bar						3

TABLE 4.0.1 (CONTINUED)

AVAILABLE DATA FOR STAINLESS STEEL ALLOYS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
17-7PH (Cont'd)	TH1050	Plate				3		
		Bar						1
21-6-9 NI40	ANNEALED	Sheet				6		
304	ANNEALED	Sheet				12		
		Plate				12		
	ANNEALED & AGED	Plate				1		
316	ANNEALED	Plate				6		
	ANNEALED AT 1950F 1HR WQ	Plate				1		
347	0.050 IN. FROM CENTERLINE	Weldment				1		
	AT CENTERLINE	Weldment				1		
	AT HEAT AFFECTED ZONE	Weldment				1		
AFC 260	2200F 1HR 1900F 1HR OQ -100F 1HR -320F 1HR 800F 2+2HR	Plate						1
	2200F 1HR 1900F 1HR OQ -100F 1HR -320F 1HR 900F 2+2HR	Plate						1
	2200F 1HR 1900F 1HR OQ -100F 1HR -320F 1HR 1000F 2+2HR	Plate						1
	2200F 1HR 1900F 1HR OQ -100F 1HR -320F 1HR 1050F 2+2HR	Plate						1
AFC 77	1800F 1HR OQ -100F 0.5HR 500F 2+2HR (COARSE GRAIN)	Plate						1
	1800F 1HR OQ -100F 0.5HR 500F 2+2HR (FINE GRAIN)	Plate						1
	1800F 1HR OQ -100F 0.5HR 700F 2+2HR (COARSE GRAIN)	Plate	1					

TABLE 4.0.1 (CONTINUED)

AVAILABLE DATA FOR STAINLESS STEEL ALLOYS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
AFC 77 (Cont'd)	1800F 1HR OQ -100F 0.5HR 700F 2+2HR (FINE GRAIN)	Plate	1					
	1800F 1HR OQ -100F 0.5HR 800F 2+2HR (COARSE GRAIN)	Plate	1					
	1800F 1HR OQ -100F 0.5HR 800F 2+2HR (FINE GRAIN)	Plate	1					
	1800F 1HR OQ -100F 0.5HR 1000F 2+2HR (COARSE GRAIN)	Plate	1					1
	1800F 1HR OQ -100F 0.5HR 1000F 2+2HR (FINE GRAIN)	Plate	1					1
	1800F 1HR OQ -100F 1HR 700F 2+2HR	Round Bar	1					
	1800F 1HR OQ -100F 1HR 800F 2+2HR	Round Bar	1					
	1900F 1HR OQ -100F 1HR 800F 2+2HR	Round Bar	1					
	2000F 1HR OQ -100F 0.5HR 500F 2+2HR	Bar						1
	2000F 1HR OQ -100F 0.5HR 500F 2+2HR + 10 PCT CW	Bar						2
	2000F 1HR OQ -100F 0.5HR 500F 2+2HR + 20 PCT CW	Bar						1
	2000F 1HR OQ -100F 0.5HR 700F 2+2HR	Bar						1
	2000F 1HR OQ -100F 0.5HR 800F 2+2HR	Bar						1
	2000F 1HR OQ -100F 0.5HR 900F 2+2HR	Bar						1
	2000F 1HR OQ -100F 0.5HR 1100F 2+2HR	Bar						1
	2000F 1HR OQ -100F 0.5HR 1400F 2+2HR	Bar						1
	2000F 1HR OQ -100F 1HR 800F 2+2HR	Round Bar	1					
	2000F 1HR OQ -100F 1HR 900F 2+2HR	Round Bar	2					

TABLE 4.0.1 (CONTINUED)

AVAILABLE DATA FOR STAINLESS STEEL ALLOYS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
AFC 77 (Cont'd)	2100F 1HR FC TO 1900F HOLD 1HR OQ -100F 4HR 500F 2+2HR	Forging						2
	AUSTENITIZED AT 2010F QUENCHED & TEMPERED AT 810F	Sheet					1	
AFC 77 (VAR)	1700F 1HR OQ 2100F 1HR MOVE TO FCE AT 1933F HELD 1HR OQ -100F 24HR 900	Forging	18					
	2100F 1HR MOVED TO FCE AT 1900F HELD 1HR OQ -100F 4HR 500F 2+2HR	Forging	7					
AM 355	MOD SCT1000	Bar						1
	SCT 850	Plate						3
		Bar						4
	SCT1000	Plate						3
		Bar						4
AM 362	H900	Bar						1
	H1000	Bar						1
AM 364	H850	Forging						1
	H950	Forging						1
CUSTOM 455	1500F 1HR OQ 900F 4HR AC	Forging	3					
	1500F 1HR OQ 950F 4HR AC	Forging	2					
	H900	Forging						1
	H950	Forging						1
	H1000	Forging				11		
PH13-8Mo	Unspecified	Extruded Bar				4		
	ANNEALED	Forging	11					

TABLE 4.0.1 (CONTINUED)

AVAILABLE DATA FOR STAINLESS STEEL ALLOYS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
PH13-8Mo (Cont'd)	AUSTENITE COND AND TRANSFORMED AT 38F AGED 1015F	Forged Bar	4					
	H950	Sheet	6					
		Forging	9					1
		Forged Bar						10
		Rolled Bar	12					
		Bar						3
	H1000	Sheet	10					
		Plate	4					
		Forging	24			8		
		Extrusion	20					8
		Forged Bar	6			22		14
		Billet				3		
		Extruded Bar				7		
		Rolled Bar	4			14		11
		Bar				1		
	H1025	Sheet	1					
	H1050	Forging	11			22		
		Rolled Bar	11					
		Bar						3
	MILL 1700F LAB 1050F 4HR	Forging	1					
	MILL 1700F LAB 1500F 1000F 4HR	Forging	1					

TABLE 4.0.1 (CONCLUDED)

AVAILABLE DATA FOR STAINLESS STEEL ALLOYS

Alloy	Condition/ Heat Treatment	Product Form	K_{Ic}	K_c	R Curve	da/dN	da/dt	K_{Iscc}
PH13-8Mo (Cont'd)	MILL 1700F LAB 1600F 1000F 4HR	Forging	1					
	RH950	Round Bar						4
		Rolled Bar	4					
	RH975	Round Bar						3
		Rolled Bar	3					
	RH1000	Round Bar						3
		Rolled Bar	1					
	TYS=140KSI	Plate						1
	TYS=180KSI	Plate						1
	TYS=190KSI	Plate						1
	TYS=200KSI	Plate						1
	TYS=210KSI	Plate						1
PH14-8Mo	SRH1050	Sheet		7				
PH15-7Mo	RH950	Rolled Bar	2					
		Bar						1
	RH1050	Rolled Bar	3					
	TH1050	Bar						1

TABLE 4.0.2

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF STAINLESS STEEL ALLOYS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$											
				Specimen Orientation											
				L-T				T-L				S-L			
				Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev	Min Spec Thk	n	Mean	Std Dev
15-5PH	H 900	Rolled Bar	2.25	---	---	---	---	1.00	6	72.7	4.5	---	---	---	---
	H1025	Forging	1.50-3.00	---	---	---	---	1.51	4	119.4	21.9	---	---	---	---
	TYS=150-165KSI	Forging	---	---	---	---	---	1.50	3	94.8	6.9	---	---	---	---
17-7PH	RH1050	Rolled Bar	1.25	---	---	---	---	1.00	3	47.0	0.7	---	---	---	---
AFC 77 (VAR)	1700F 1HR OQ 2100F 1HR MOVE TO FCE AT 1933F HELD 1HR OQ -100F 24HR 900	Forging	6.00	0.50	7	48.6	3.1	0.50	7	50.8	1.3	---	---	---	---
	2100F 1HR MOVED TO FCE AT 1900F HELD 1HR OQ -100F 4HR 500F 2+2HR	Forging	6.00	2.01	2	110.5	5.0	2.01	2	108.0	5.7	---	---	---	---
CUSTOM 455	1500F 1HR OQ 900F 4HR AC	Forging	4.00	0.48	3	46.2	3.3	---	---	---	---	---	---	---	---
	1500F 1HR OQ 950F 4HR AC	Forging	4.00	0.48	2	72.1	7.8	---	---	---	---	---	---	---	---
PH13-8Mo	ANNEALED	Forging	3.00	1.01	5	114.1	15.7	1.00	6	99.6	22.4	---	---	---	---
	AUSTENITE COND AND TRANSFORMED AT 38F AGED 1015F	Forged Bar	2.20	1.63	2	103.0	19.4	1.63	2	89.6	1.8	---	---	---	---
	H 950	Sheet	1.00-2.25	1.00	2	58.4	6.5	---	4	69.4	16.1	---	---	---	---
		Forging	4.00-8.00	---	9	70.3	16.0	---	---	---	---	---	---	---	---
		Rolled Bar	2.25	1.00	3	66.9	2.9	1.00	6	63.5	1.7	0.75	3	74.1	2.1

TABLE 4.0.2 (CONCLUDED)

PLANE STRAIN FRACTURE TOUGHNESS VALUES OF STAINLESS STEEL ALLOYS AT ROOM TEMPERATURE

Alloy	Condition/ Heat Treatment	Product Form	Range of Product Thickness (in.)	K_{Ic} $(Ksi\sqrt{in})$ Specimen Orientation L-T Min Spec Thk	L-T n	L-T Mean	L-T Std Dev	T-L Min Spec Thk	T-L n	T-L Mean	T-L Std Dev	S-L Min Spec Thk	S-L n	S-L Mean	S-L Std Dev
PH13-8Mo (Cont'd)	H1000	Sheet	1.50-2.25	---	6	105.6	4.8	1.00	4	96.2	5.2	---	---	---	---
		Plate	4.00	0.98	3	94.7	3.6	---	---	---	---	---	---	---	---
		Forging	2.75-8.00	0.75	12	101.6	11.0	0.75	7	88.1	17.1	---	---	---	---
		Extrusion	1.50	1.00	8	68.5	5.5	1.00	6	66.2	2.1	---	---	---	---
		Forged Bar	1.00	1.00	2	114.2	0.9	1.00	3	122.7	3.0	---	---	---	---
		Rolled Bar	1.50	1.00	2	90.0	7.1	1.00	2	75.0	4.2	---	---	---	---
	H1050	Forging	2.00-3.00	2.00	3	143.3	9.2	2.00	2	122.0	2.2	---	---	---	---
		Rolled Bar	2.25	1.00	3	103.1	4.6	1.00	6	94.9	7.8	0.75	2	92.2	4.2
PH15-7Mo	RH 950	Rolled Bar	1.25	---	---	---	---	1.00	2	30.6	0.1	---	---	---	---
	RH1050	Rolled Bar	1.25	---	---	---	---	1.00	3	40.2	1.5	---	---	---	---

TABLE 4.0.4.1

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR STAINLESS STEEL ALLOYS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: Unspecified **STRESS RATIO:** 0.05 - 0.1 **FREQUENCY:** 1.67 - 30. Hz

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
304	ANNEALED	SHEET	0.05	10			0.2	3.06		
			0.05	15			0.13	2.83		
			0.05	10-15			0.14	3.09		
			0.1	1.67				2.82		
			0.1	6				2.76		
			0.1	1.67-6				2.59		
	ANNEALED & AGED	PLATE	0.05	3				1.39		
316	ANNEALED	PLATE	0.05	10				2.49		
347	.050 IN. FROM CENTERLINE	WELDMENT	0.1	30					10.26	
	AT CENTERLINE	WELDMENT	0.1	30					13.37	
	AT HEAT AFFECTED ZONE	WELDMENT	0.1	30					16.47	

TABLE 4.0.4.2

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR STAINLESS STEEL ALLOYS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: L-T **STRESS RATIO: -1. - 0.8** **FREQUENCY: 0.03 - 30. Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
15-5PH	H1025	FORGING	-1	5			0.3	2.76	21.46	
			0.1	10-20				2.62	23.26	
			0.4	10-15		0.05	0.42	2.85	24.48	
			0.8	20-30			0.54	4.03		
		BAR	0.5	10					23.64	102.42
17-4PH	H 900	PLATE	0.08	20			0.31	3.41	53.01	
17-7PH	TH1050	PLATE	0.1	20		0.03	0.45			
304	ANNEALED	PLATE	0.	0.03					55.99	
			0.	6.67				1.95	27.99	
CUSTOM 455	H1000	FORGING	0.1	10-30				2.76		
			0.3	20-30				3.72		
PH13-8Mo	H1000	FORGING	0.1	5-10				5.7	30.78	127.33
		BAR	0.02	10					31.58	
	H1050	FORGING	-1	5			0.31	3.31	26.63	
			0.1	5			0.36	3.64	28.08	
			0.1	20				3.5	24.45	183.59
			0.4	5		0.06	0.56	4.82		
			0.4	5-20		0.06	0.53	4.55	32.68	
			0.4	20		0.05	0.53	4.28	31.06	
			0.8	15-30		0.1	0.89	5.33		

TABLE 4.0.4.3

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR STAINLESS STEEL ALLOYS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: T-L **STRESS RATIO: 0. - 0.8** **FREQUENCY: 5. - 30. Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle)					
					ΔK Level (Ksi√in)					
					2.5	5.0	10.0	20.0	50.0	100.0
15-5PH	H1025	FORGING	0.1	15				2.88	26.12	
			0.4	15-20		0.05	0.46	3.53		
			0.8	20-30			0.7			
		BAR	0.05	10					14.43	151.46
17-4PH	H1025	ROUND BAR	0.1	30			0.06	2.01		
			0.1	30			0.06	2.04		
			0.5	10				5.88		
			0.5	10				5.88		
			0.5	30		0.03	0.51			
			0.5	30		0.04	0.51			
17-7PH	TH1050	PLATE	0.1	20		0.02	0.38	4.59		
21-6-9 NI40	ANNEALED	SHEET	0.01				0.34	2.35	57.29	
			0.1				0.56	3.56	78.59	
			0.2				0.4	3.95	71.4	
304	ANNEALED	PLATE	0.	6.67				1.86	32.46	

TABLE 4.0.4.3 (CONCLUDED)

FATIGUE CRACK GROWTH RATE (FCGR) COMPARISON AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK FOR STAINLESS STEEL ALLOYS IN LAB AIR AT ROOM TEMPERATURE

ORIENTATION: T-L **STRESS RATIO: 0. - 0.8** **FREQUENCY: 5. - 30. Hz**

ALLOY	CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle)					
					ΔK Level (Ksi$\sqrt{in}$)					
					2.5	5.0	10.0	20.0	50.0	100.0
CUSTOM 455	H1000	FORGING	0.1	10					25	
			0.1	20				3.11		
			0.1	20-30				2.52		
PH13-8Mo	H1000	FORGING	0.1	5-10				5.74	31.6	139.72
	H1050	FORGING	0.1	20		0.03	0.27	2.99	23.2	
			0.1	7-20		0.04	0.31	3.07	25.59	
			0.4	20		0.05	0.53	4.3	27.43	
			0.4	5-20		0.06	0.54	4.43	29.07	
			0.8	15-30		0.1	0.91	5.42		

TABLE 4.0.5

INDIVIDUAL STRESS CORROSION CRACKING THRESHOLD DATA FOR STAINLESS STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in})$ ENVIRONMENTS				
				SUMP TANK WATER	3.5% NACL	20% NACL	SEACOAST ATMOSPHERE	INDUSTRIAL ATMOSPHERE
AFC 77	1800F 1HR OQ, -100F 0.5 HR, 500F 2&2 HR, (Coarse G.S.)	Plate	---		15			
	2000F 1HR OQ, -100F 0.5 HR, 700F 2&2 HR	Bar	---		50			
	2000F 1HR OQ, -100F 0.5 HR, 800F 2&2 HR	Bar	---		40			
	2000F 1HR OQ, -100F 0.5 HR, 900F 2&2 HR	Bar	---		35			
	2000F 1HR OQ, -100F 0.5 HR, 1100F 2&2 HR	Bar	---		10			
	2000F 1HR OQ, -100F 0.5 HR, 500F 2&2 HR, & 10PCT CW, 1000F	Bar	---		30			
	2000F 1HR OQ, -100F 0.5 HR, 500F 2&2 HR, & 10PCT CW, 700F	Bar	---		90			
	2000F 1HR OQ, -100F 0.5 HR, 500F 2&2 HR, & 20PCT CW, 700F	Bar	---		48			
AFC 260	2200F 1HR, 1900F 1HR OQ, -100F 1HR, -300F 1HR, 900F, 2&2 HR	Plate	T-L		40			
	2200F 1HR, 1900F 1HR OQ, -100F 1HR, -300F 1 HR 1000F 2&2 HR	Plate	T-L		45			
	2200F 1HR, 1900F 1HR OQ, -100F 1HR, -300F 1HR, 1050F 2&2 HR	Plate	T-L		37			
AM 355	SCT 850	Plate	T-L			8	24	45
		Bar	T-L			6	18	18
	SCT 1000	Plate	T-L			37	52	99
		Bar	T-L			28	35	66
AM 362	H900	Bar	---		12			
	H1000	Bar	---		31			

TABLE 4.0.5 (CONCLUDED)

INDIVIDUAL STRESS CORROSION CRACKING THRESHOLD DATA FOR STAINLESS STEEL ALLOYS AT ROOM TEMPERATURE

ALLOY	CONDITION/HT	PRODUCT FORM	SPECIMEN ORIENTATION	K_{Iscc} $(Ksi\sqrt{in})$ ENVIRONMENTS: SUMP TANK WATER	3.5% NACL	20% NACL	SEACOAST ATMOSPHERE	INDUSTRIAL ATMOSPHERE
CUSTOM 455	H900	Forging	---		60			
	H950	Forging	---		72			
PH13-8Mo	H950	Forging	T-L		74			
		Forged Bar	L-T	48				
		Bar	T-L			46	31	59
	H1000	Extrusion	L-T	55				
		Forged Bar	L-T	88				
		Forged Bar	T-L	100				
		Rolled Bar	L-T	70				
	H1050	Bar	T-L			65	44	83
	TYS = 210 KSI	Plate	T-L		120			
PH15-7Mo	RH 950	Bar	---		14			
	RH 1050	Bar	---		18			
15-5 PH	H900	Bar	---			33	36	68
15-5 PH(VM)	H900	Forging	---		56			
17-4 PH	H900	Bar	---		52			
17-7 PH	RH1050	Bar	T-L			65	12	24
	TH1050	Bar	---		16			

TABLE 4.1.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR STAINLESS STEEL ALLOY 15-5PH AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	H1025	---	---	---	119.4	21.9	4	---	---	---
	TYS=150-165KSI	---	---	---	94.8	6.9	3	---	---	---
Rolled Bar	H900	---	---	---	72.7	4.5	6	---	---	---

TABLE 4.1.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 15-5PH AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	BAR	0.5	1				9.97		

TABLE 4.1.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 15-5PH AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	FORGING	0.1	1			0.26	8.74	94.12	
		0.8	1		0.06	1.12	10.18		

TABLE 4.1.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 15-5PH AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	FORGING	-1	5			0.3	2.76	21.46	
		0.1	10-20				2.62	23.26	
		0.4	10-15		0.05	0.42	2.85	24.48	
		0.8	20-30			0.54	4.03		
	BAR	0.5	10					23.64	102.42

TABLE 4.1.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 15-5PH AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: 3.5% NaCl**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	BAR	0.05	1					39.38	

TABLE 4.1.1.2.5

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
15-5PH AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	FORGING	0.1	1			0.43	11.57	110.85	
		0.8	1		0.06	1.14	14.7		

TABLE 4.1.1.2.6

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 15-5PH AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
TUS=150-165KSI	BILLET	-1				0.26	4.04	44.99	1703.72
		-0.2				0.14	3.17	32.97	1088.2
		0.04				0.14	3.05	33.26	1126.65
		0.4				0.76	5.12	126.15	

TABLE 4.1.1.2.7

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 15-5PH AT ROOM TEMPERATURE

ORIENTATION: T-L | **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	FORGING	0.1	15				2.88	26.12	
		0.4	15-20		0.05	0.46	3.53		
		0.8	20-30			0.7			
	BAR	0.05	10					14.43	151.46

TABLE 4.1.1.2.8

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 15-5PH AT ROOM TEMPERATURE

ORIENTATION: S-L **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
TUS=150-165KSI	BILLET	-1					4.78	51.6	
		-1					4.78	51.6	
		-0.2					3.46	39.64	
		-0.2					3.46	39.64	
		0.04					3.16	37.87	
		0.04					3.16	37.87	
		0.4					6.04		
		0.4					6.04		

TABLE 4.1.1.3

STAINLESS STEEL 15-5PH K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi $\cdot \sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
H 900	Rolled Bar	2.25	R.T.	T-L	171.0	4.000	2.000	CT	2.068	0.54	79.40	72.7	4.5	1973	86688
		2.25			171.0	2.000	1.000	CT	1.051	0.49	75.80			1973	86688
		2.25			171.0	2.000	1.000	CT	1.040	0.38	66.50			1973	86688
		2.25			171.0	2.000	1.000	CT	1.049	0.46	73.10			1973	86688
		2.25			171.0	4.000	2.000	CT	2.057	0.43	70.90			1973	86688
		2.25			171.0	4.000	2.000	CT	2.064	0.42	70.50			1973	86688
H 900	Rolled Bar	4.00	R.T.	L-R	185.0	2.000	1.000	NB	1.000	0.55	86.90	---	---	1972	84212
H1025	Forging	3.00	-65	L-T	169.0	1.997	1.000	CT	1.016	0.48	73.80	66.6	6.5	1987	DA007
		3.00			169.0	1.997	1.000	CT	1.010	0.43	70.20			1987	DA007
		1.50			172.3	3.005	1.501	CT	1.512	0.31	60.30			1987	DA006
		1.50			172.3	3.008	1.500	CT	1.533	0.32	62.00			1987	DA006
H1025	Forging	3.00	-65	T-L	167.9	2.000	1.001	CT	1.028	0.30	58.10	55.5	1.8	1987	DA007
		3.00			167.9	1.996	1.000	CT	1.021	0.27	55.00			1987	DA007
		1.50			171.3	3.010	1.494	CT	1.560	0.25	54.40			1987	DA006
		1.50			171.3	3.008	1.492	CT	1.551	0.25	54.30			1987	DA006
H1025	Forging	3.00	R.T.	T-L	158.0	4.007	1.998	CT	2.036	1.95	139.60	119.4	21.9	1987	DA007
		3.00			158.0	4.008	1.999	CT	2.036	1.87	136.60			1987	DA007
		1.50			160.6	3.000	1.513	CT	1.567	0.91	97.00			1987	DA006
		1.50			160.6	3.001	1.514	CT	1.543	1.05	104.20			1987	DA006
H1025	Rolled Bar	4.00	0	C-R	166.0	2.960	1.500	CT	---	0.35	62.30	61.2	1.6	1992	NH007
		4.00			166.0	2.960	1.500	CT	---	0.33	60.10			1992	NH007

TABLE 4.1.1.3 (CONCLUDED)

STAINLESS STEEL 15-5PH K_{Ic}

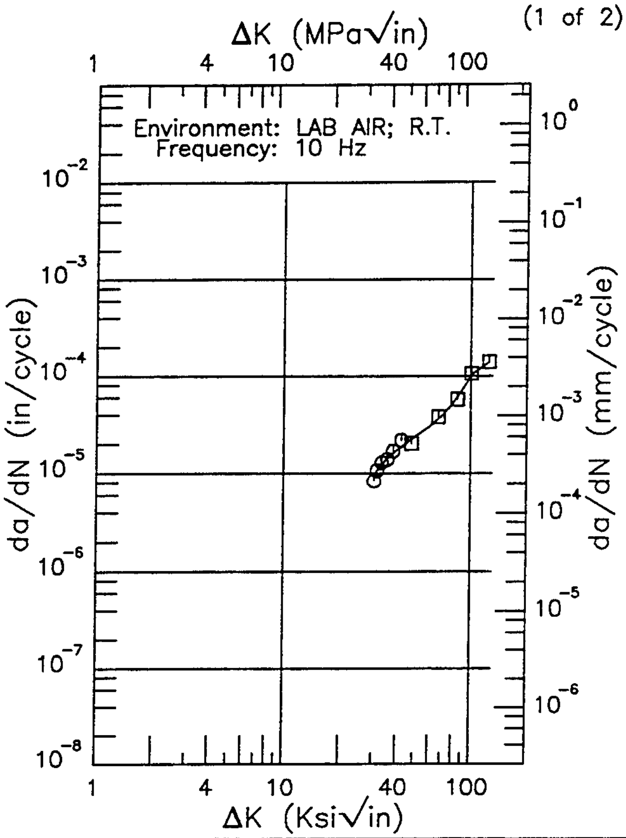
CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic} K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} K_{Ic} MEAN	K_{Ic} STAN DEV	DATE	REFER
H1100	Rolled Bar	4.00	0	C-R	147.3	1.960	1.500	CT	---	0.72	79.00	80.7	7.1	1992	NH007
		4.00			147.3	2.960	1.500	CT	---	0.90	88.50			1992	NH007
		4.00			166.0	2.960	1.500	CT	---	0.50	74.60			1992	NH007
H900	Rolled Bar	4.00	0	C-R	171.5	2.960	1.500	CT	---	0.24	53.30	50.8	3.2	1992	NH007
		4.00			171.5	2.960	1.500	CT	---	0.19	47.20			1992	NH007
		4.00			171.5	2.960	1.500	CT	---	0.23	51.80			1992	NH007
TYS=150-165KSI	Forging	---	R.T.	T-L	155.0	3.000	1.500	CT	---	1.09	102.50	94.8	6.9	1978	BW007
		---			155.0	3.000	1.500	CT	---	0.89	92.70			1978	BW007
		---			155.0	3.000	1.500	CT	---	0.83	89.20			1978	BW007

EF 15–5PH

Condition/Ht: H1025
Form: 1.5 in. Bar
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.5

Yield Strength: 150.7 ksi
Ult. Strength: 156.2 ksi
Specimen Thk: 1.5 in.
Specimen Width: 3 in.
Ref: 92270

(1 of 2)



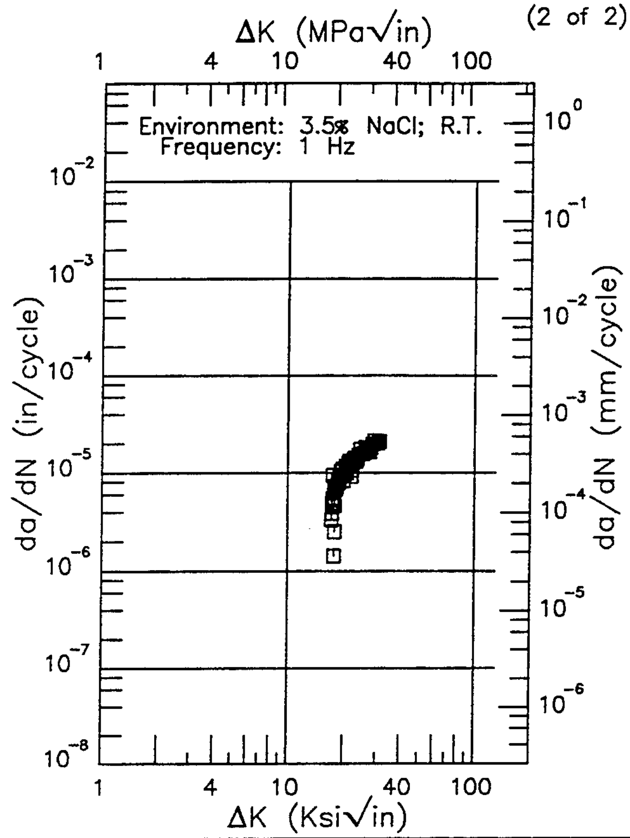
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
30.17 (min)	9.66
35.	13.8
40.	17.4
50.	23.6
60.	30.2
70.	39.1
80.	52.4
90.	72.6
100.	102.
124.79 (max)	139.

RMS % Error 7.96

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.18 (min)	5.06
20.	9.97
25.	15.7
30.	20.3
30.88 (max)	21.5

RMS % Error 19.71

Life Prediction Ratio Summary

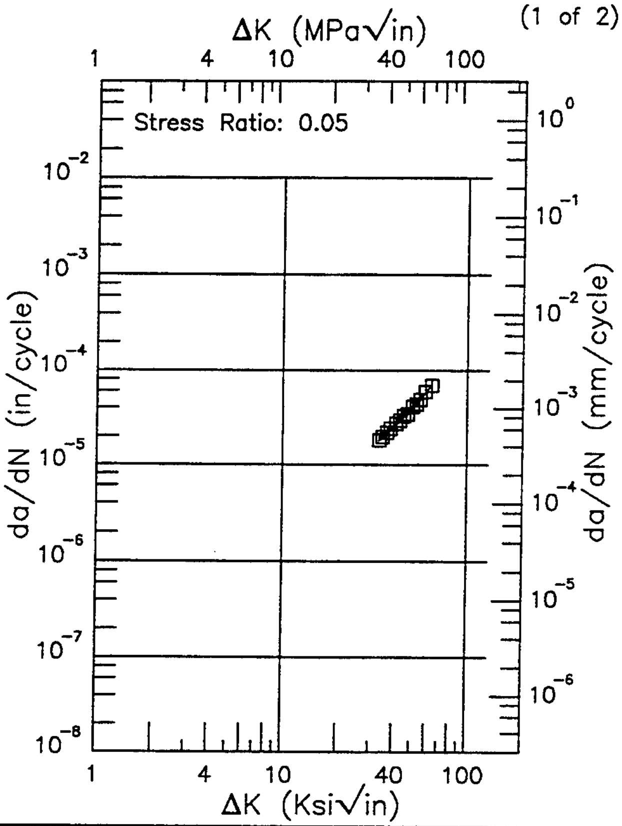
0. .5 .8 1.25 2.

Figure 4.1.3.1.1

Condition/Ht: H1025
Form: 1.5 in. Bar
Specimen Type: CT
Orientation: T–L
Frequency: 1 Hz
Environment: 3.5% NACL; RT

Yield Strength: 151.2 ksi
Ult. Strength: 156.1 ksi
Specimen Thk: 1.5 in.
Specimen Width: 3 in.
Ref: 92270

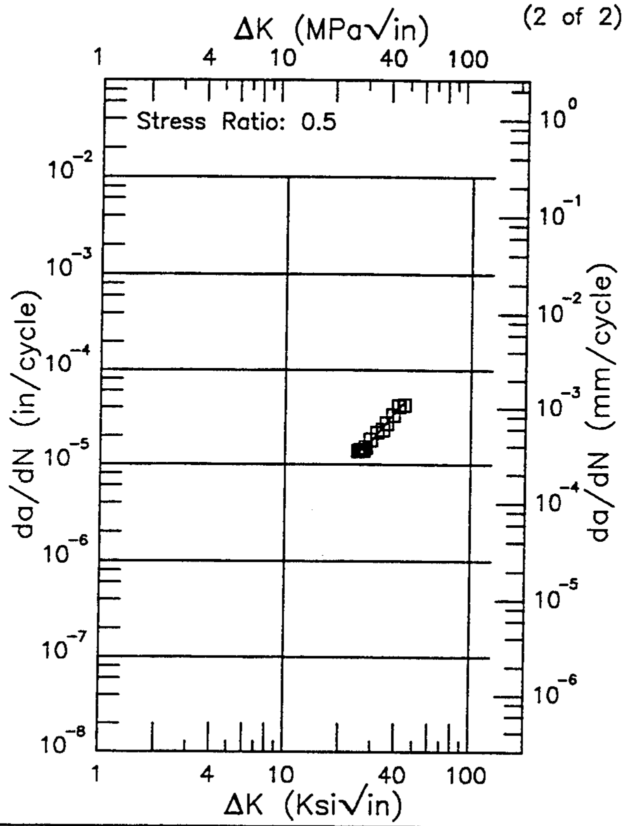
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
33.23 (min)	17.9
35.	19.9
40.	25.6
50.	39.4
60.	60.4
63.17 (max)	69.7

RMS % Error	Life Prediction Ratio Summary
1.93	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
24.76 (min)	13.2
25.	13.4
30.	18.6
35.	26.7
40.	36.7
43.53 (max)	44.1

RMS % Error	Life Prediction Ratio Summary
4.26	0. .5 .8 1.25 2.

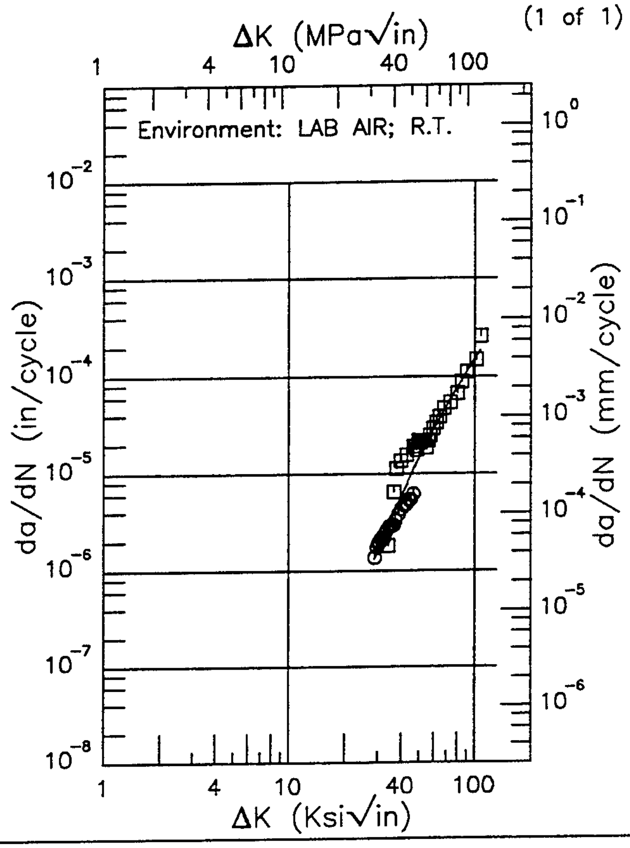
Figure 4.1.3.1.2

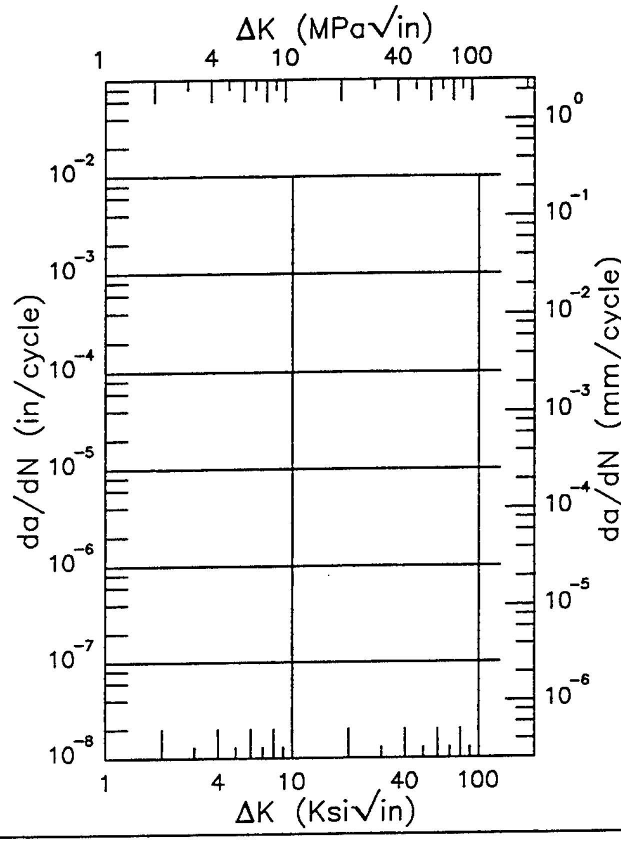
E 15–5PH

Condition/Ht: H1025
Form: 1.5 in. Bar
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.05
Frequency: 10 Hz

Yield Strength: 151.2 ksi
Ult. Strength: 156.1 ksi
Specimen Thk: 1.5 in.
Specimen Width: 3 in.
Ref: 92270

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
28.88 (min)	1.33
30.	1.59
35.	3.26
40.	5.84
50.	14.4
60.	28.5
70.	48.9
80.	75.9
90.	110.
100.	151.
107.17 (max)	186.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
42.42

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.1.3.1.3

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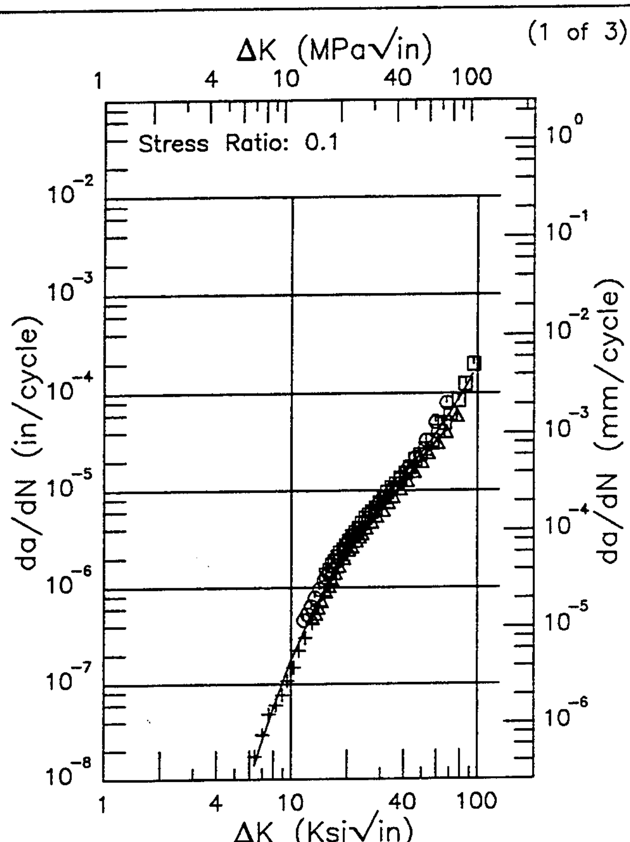
R

15–5PH

Condition/Ht: H1025
Form: 3 in. Forging
Specimen Type: CT
Orientation: L–T
Frequency: 10 – 30 Hz
Environment: LAB AIR; RT

Yield Strength: 159 – 160.6 ksi
Ult. Strength:
Specimen Thk: 0.243 – 0.268 in.
Specimen Width: 1.995 – 2 in.
Ref: DA007;DA006

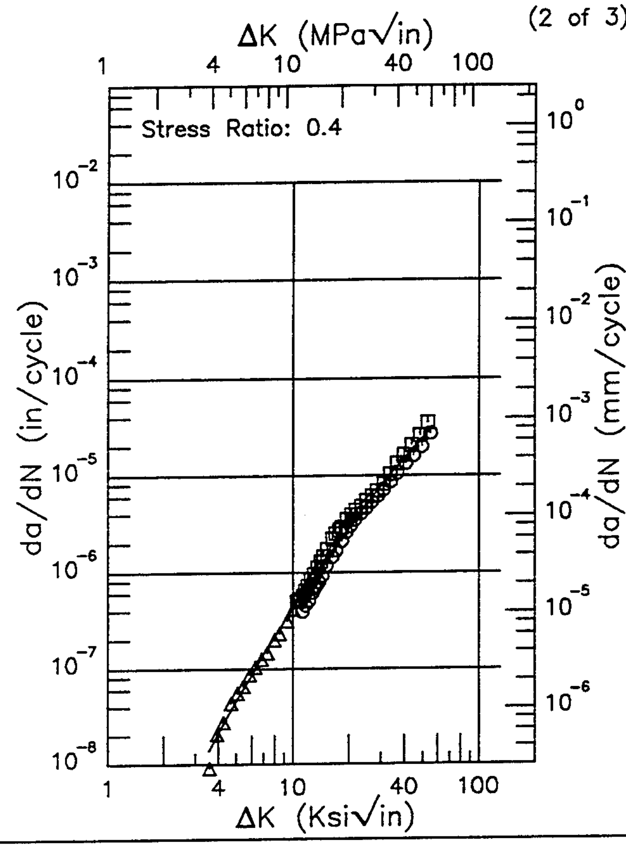
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.35 (min)	0.0140
7.	0.0259
8.	0.0567
9.	0.106
10.	0.179
16.	1.18
20.	2.38
30.	7.05
40.	14.2
60.	39.4
80.	90.9
94.51 (max)	158.

RMS % Error	Life Prediction Ratio Summary
17.82	△ ◻ + 0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.56 (min)	0.0138
4.	0.0212
5.	0.0464
6.	0.0858
7.	0.141
8.	0.215
9.	0.309
10.	0.423
16.	1.59
20.	2.85
30.	7.73
40.	15.0
54.93 (max)	29.9

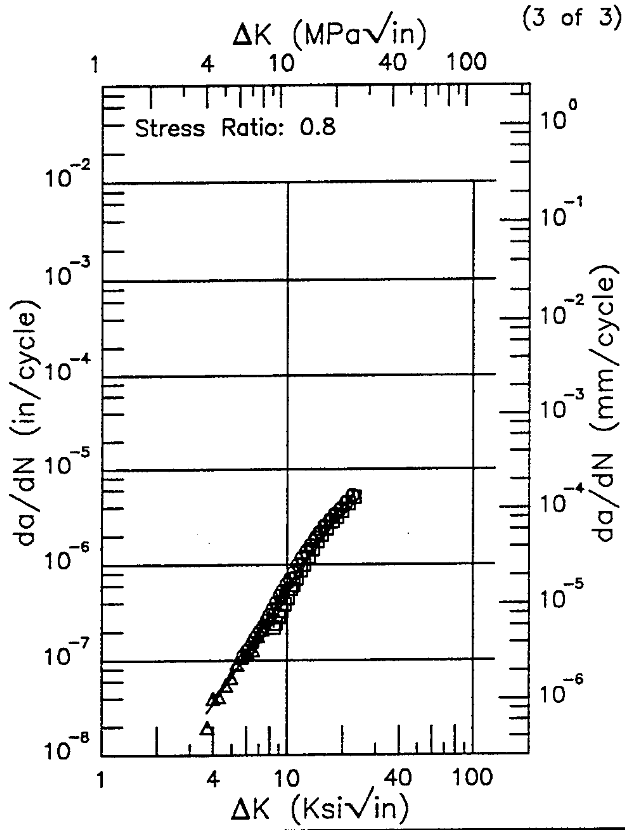
RMS % Error	Life Prediction Ratio Summary
16.24	○ ◻ △ 0. .5 .8 1.25 2.

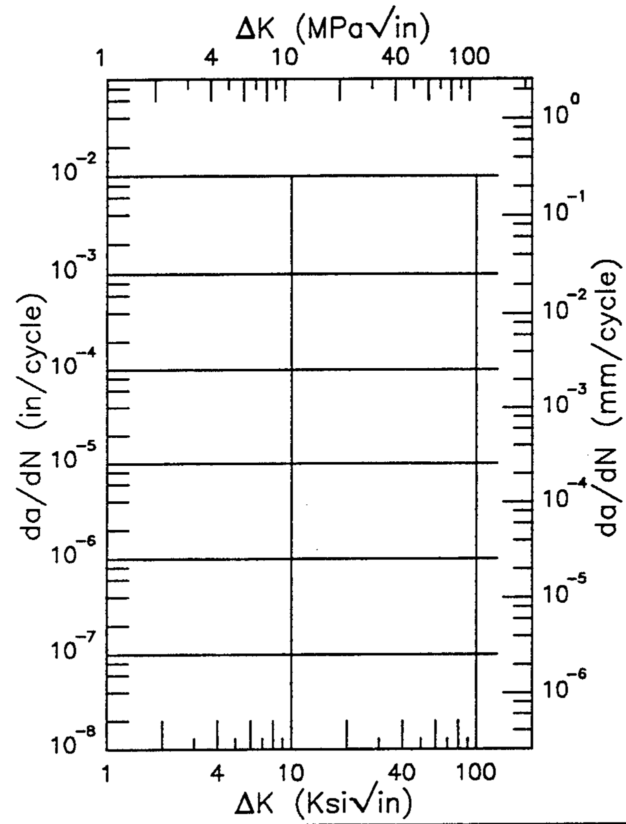
Figure 4.1.3.1.4

Condition/Ht: H1025
Form: 3 in. Forging
Specimen Type: CT
Orientation: L–T
Frequency: 10 – 30 Hz
Environment: LAB AIR; RT

Yield Strength: 159 – 160.6 ksi
Ult. Strength:
Specimen Thk: 0.243 – 0.268 in.
Specimen Width: 1.995 – 2 in.
Ref: DA007;DA006

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.69 (min)	0.0278
4.	0.0348
5.	0.0667
6.	0.116
7.	0.187
8.	0.284
9.	0.410
10.	0.567
13.	1.25
16.	2.26
20.	4.06
22.80 (max)	5.56

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
13.26	0. .5 .8 1.25 2.

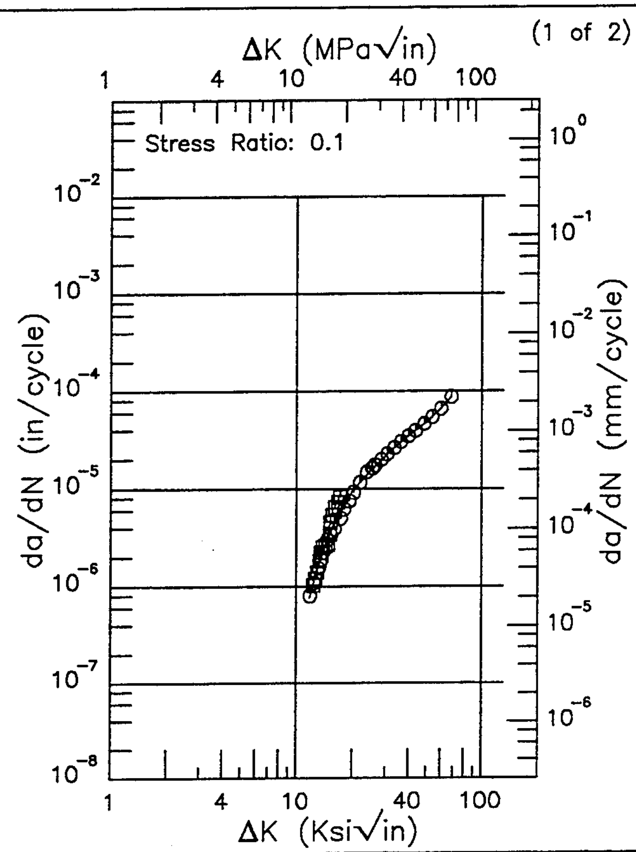
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

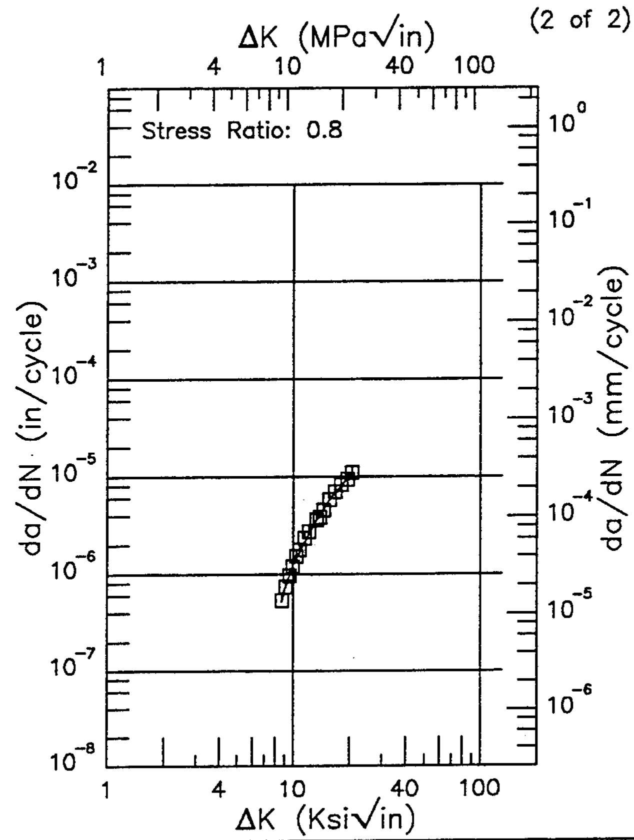
Figure 4.1.3.1.4 (Concluded)

R 15–5PH

Condition/Ht: H1025
Form: 3 in. Forging
Specimen Type: CT
Orientation: L–T
Frequency: 1 Hz
Environment: DIST WATER; RT

Yield Strength: 159 – 160.6 ksi
Ult. Strength:
Specimen Thk: 0.25 – 0.267 in.
Specimen Width: 1.995 – 1.998 in.
Ref: DA006;DA007





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.80 (min)	0.766
13.	1.55
16.	4.63
20.	9.56
25.	15.3
30.	21.6
35.	28.3
40.	34.9
50.	47.6
60.	66.4
68.13 (max)	86.8

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.65 (min)	0.524
9.	0.699
10.	1.28
13.	3.31
16.	6.09
20.	10.1
20.62 (max)	10.6

RMS % Error	Life Prediction Ratio Summary
14.27	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
4.17	0. .5 .8 1.25 2.

Figure 4.1.3.1.5

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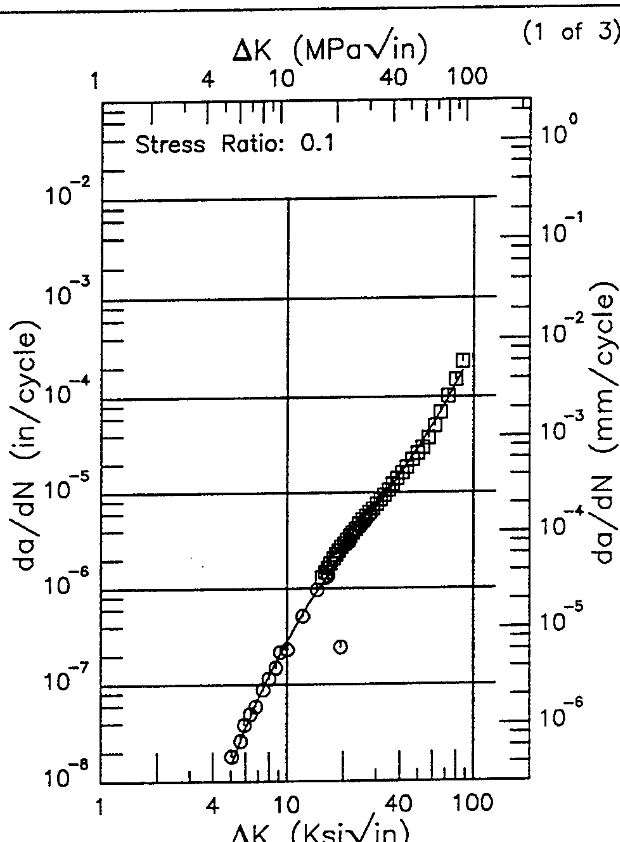
R 15-5PH

Condition/Ht: H1025
Form: 3 in. Forging
Specimen Type: CT
Orientation: T-L
Frequency: 15 - 30 Hz
Environment: LAB AIR; RT

Yield Strength: 158 - 160.6 ksi
Ult. Strength:
Specimen Thk: 0.249 - 0.268 in.
Specimen Width: 1.997 - 2.001 in.
Ref: DA007;DA006

(1 of 3)

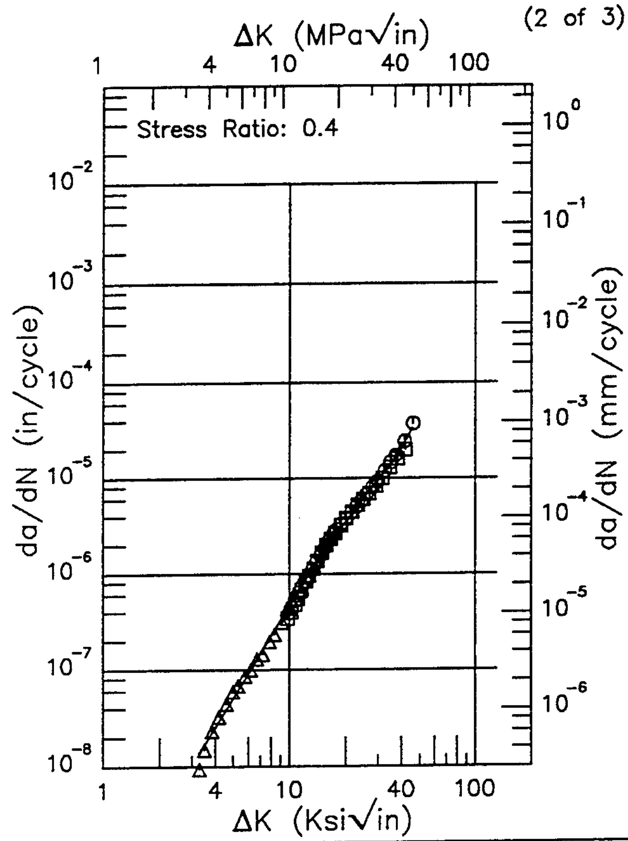


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.03 (min)	0.0153
6.	0.0360
7.	0.0712
8.	0.123
9.	0.193
10.	0.282
16.	1.26
20.	2.37
30.	7.05
40.	15.4
60.	51.1
80.	135.
87.16 (max)	186.

RMS % Error: 17.70

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.27 (min)	0.0138
3.5	0.0169
4.	0.0252
5.	0.0504
6.	0.0899
7.	0.147
8.	0.226
9.	0.329
10.	0.459
16.	1.90
20.	3.52
30.	9.51
40.	20.7
45.78 (max)	33.4

RMS % Error: 9.45

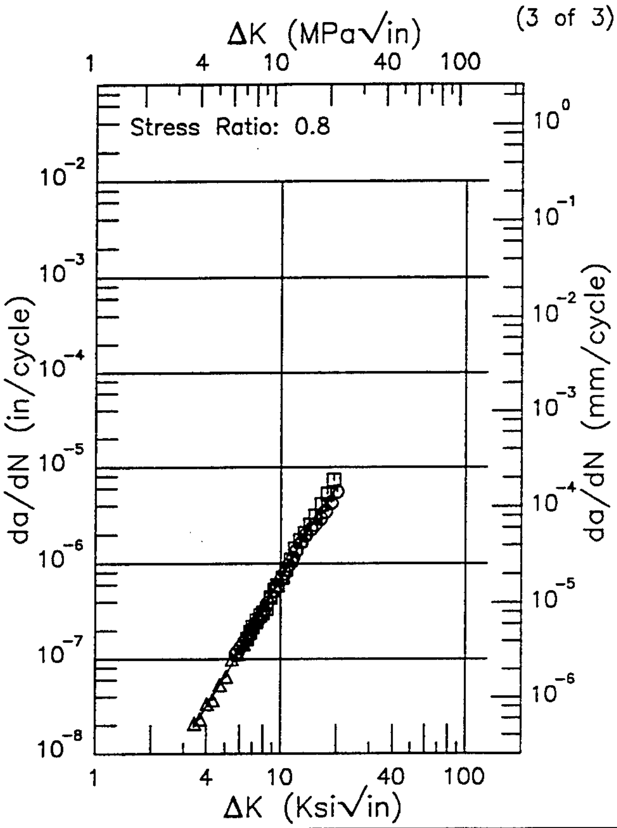
Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

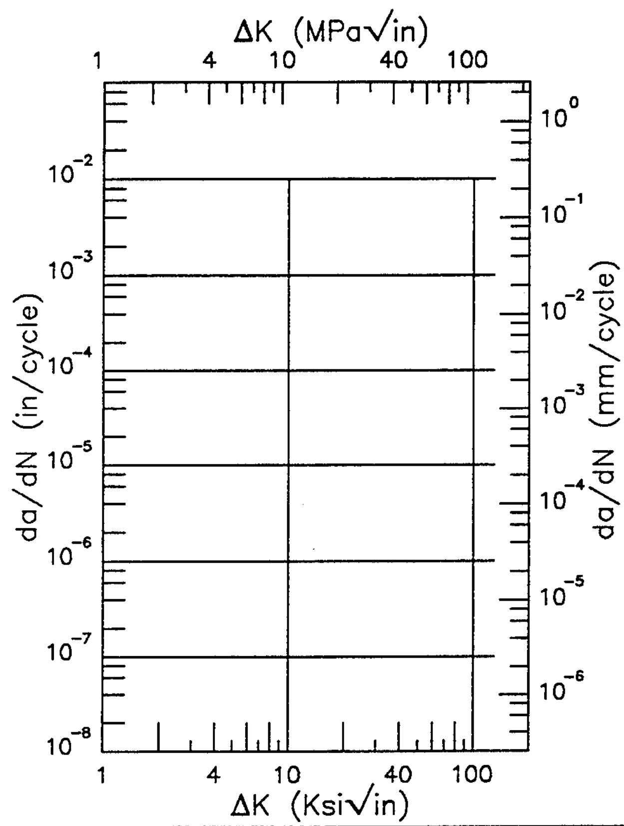
Figure 4.1.3.1.6

Condition/Ht: H1025
Form: 3 in. Forging
Specimen Type: CT
Orientation: T–L
Frequency: 15 – 30 Hz
Environment: LAB AIR; RT

Yield Strength: 158 – 160.6 ksi
Ult. Strength:
Specimen Thk: 0.249 – 0.268 in.
Specimen Width: 1.997 – 2.001 in.
Ref: DA007;DA006

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.40 (min)	0.0190
3.5	0.0208
4.	0.0317
5.	0.0658
6.	0.122
7.	0.206
8.	0.325
9.	0.486
10.	0.696
13.	1.67
16.	3.24
19.95 (max)	6.22

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
8.17	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.1.3.1.6 (Concluded)

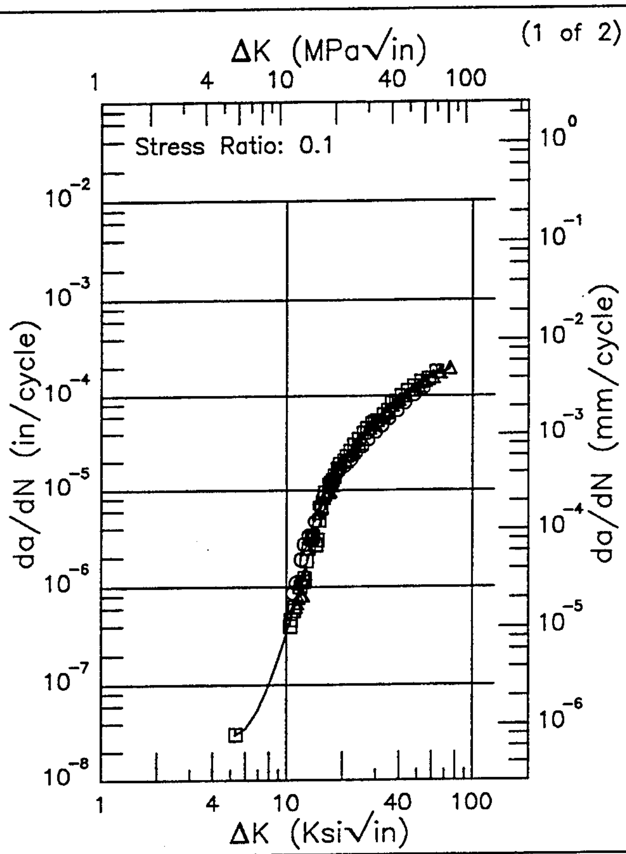
R

15-5PH

Condition/Ht: H1025
Form: 3 in. Forging
Specimen Type: CT
Orientation: T-L
Frequency: 1 Hz
Environment: DIST WATER; RT

Yield Strength: 158 - 160.6 ksi
Ult. Strength:
Specimen Thk: 0.249 - 0.267 in.
Specimen Width: 1.997 - 2 in.
Ref: DA006;DA007

(1 of 2)



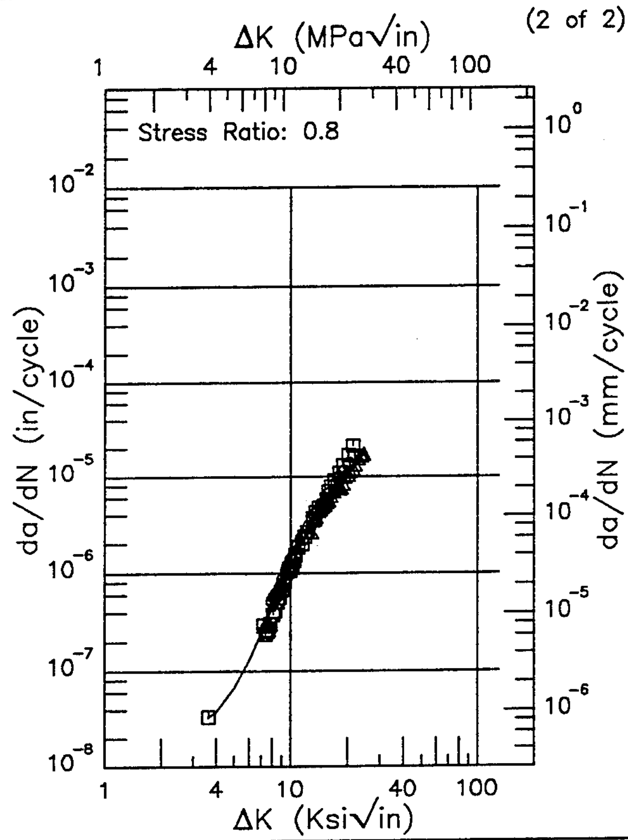
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.29 (min)	0.0301
6.	0.0352
7.	0.0556
8.	0.0997
9.	0.186
10.	0.347
13.	1.83
16.	6.54
20.	20.1
25.	39.9
30.	52.1
35.	61.7
40.	76.0
50.	129.
60.	163.
70.	173.
74.84 (max)	197.

RMS % Error
25.15

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.62 (min)	0.0333
4.	0.0380
5.	0.0664
6.	0.128
7.	0.243
8.	0.438
9.	0.739
10.	1.16
13.	3.20
16.	6.30
20.	11.7
24.48 (max)	17.2

RMS % Error
13.69

Life Prediction Ratio Summary

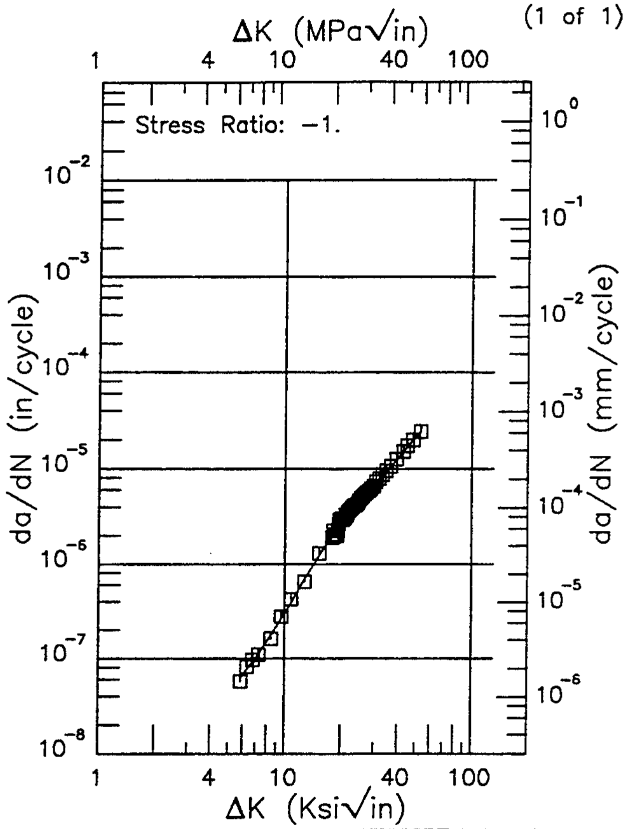
0. .5 .8 1.25 2.

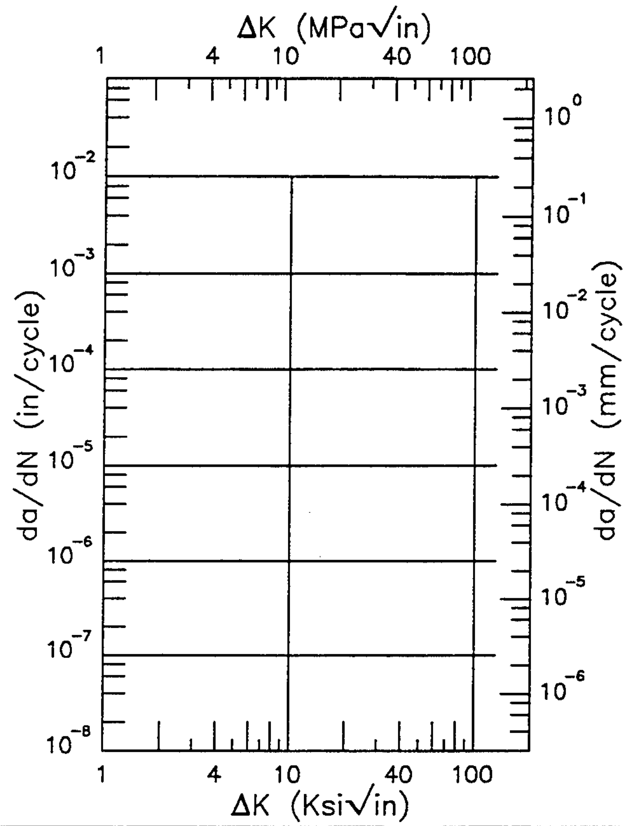
Figure 4.1.3.1.7

Condition/Ht: H1025
Form: 3 in. Forging
Specimen Type: CCP (max load specified)
Orientation: L–T
Frequency: 5 Hz
Environment: LAB AIR; RT

Yield Strength: 159 ksi
Ult. Strength:
Specimen Thk: 0.2 in.
Specimen Width: 4.001 in.
Ref: DA006

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.82 (min)	0.0624
6.	0.0670
7.	0.100
8.	0.148
9.	0.214
10.	0.303
13.	0.732
16.	1.44
20.	2.76
25.	4.73
30.	6.91
35.	9.52
40.	12.9
50.	21.5
52.75 (max)	23.8

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
5.44

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

Figure 4.1.3.1.8

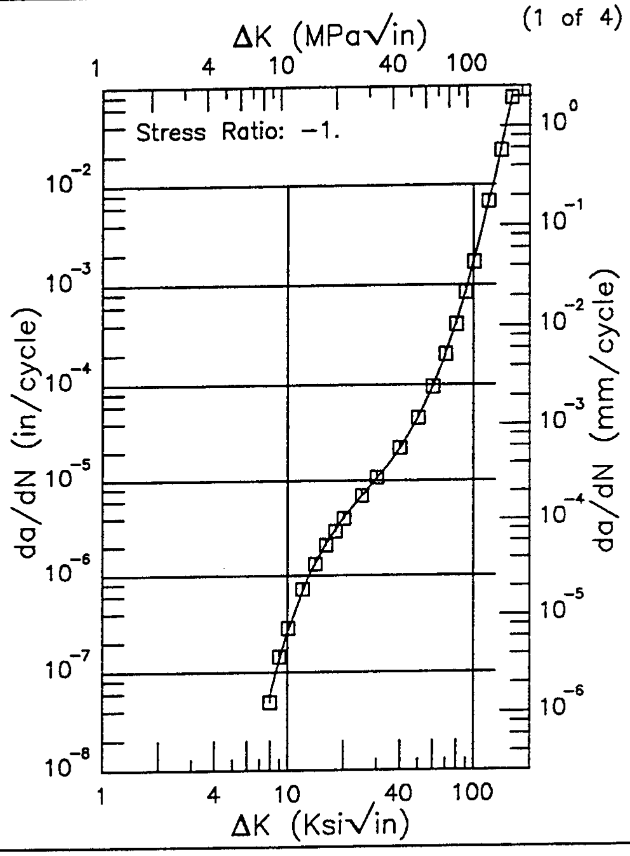
R

15–5PH

Condition/Ht: TUS=150–165KSI
Form: 0.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: T–L
Frequency:
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: BW005

(1 of 4)



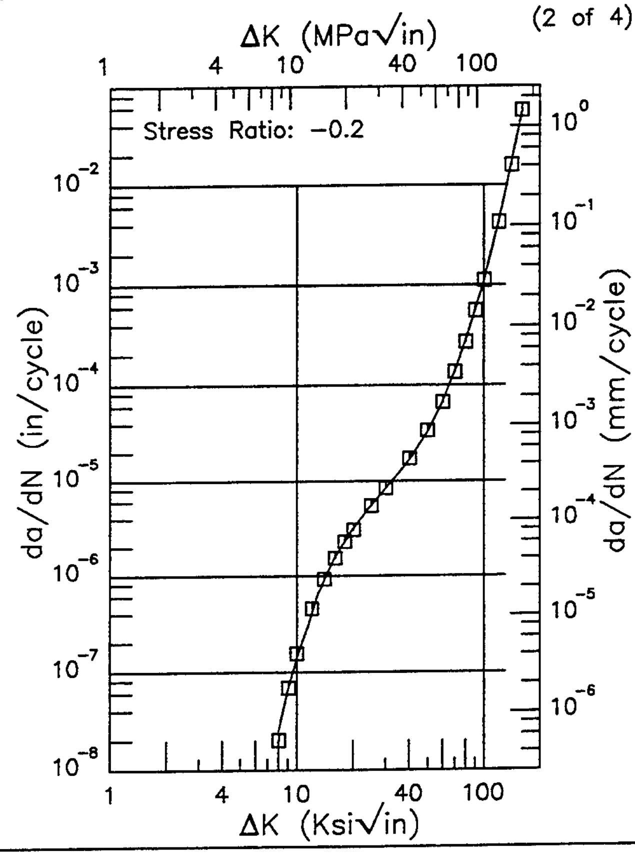
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.00 (min)	0.0583
9.	0.136
10.	0.263
16.	2.12
20.	4.04
30.	10.5
40.	21.8
60.	94.4
80.	412.
100.	1704.
130.	12130.
160.00 (max)	74606.

RMS % Error 5.00

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.00 (min)	0.0245
9.	0.0660
10.	0.143
16.	1.56
20.	3.17
30.	8.33
40.	16.6
60.	66.8
80.	275.
100.	1088.
130.	8142.
160.00 (max)	55999.

RMS % Error 5.56

Life Prediction Ratio Summary

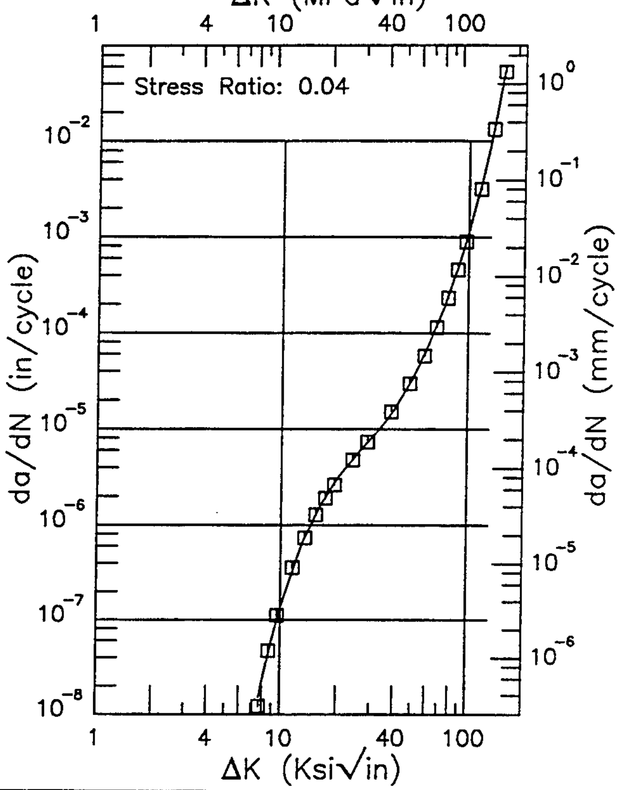
0. .5 .8 1.25 2.

Figure 4.1.3.1.9

Condition/Ht: TUS=150–165KSI
Form: 0.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: T–L
Frequency:
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: BW005

(3 of 4)



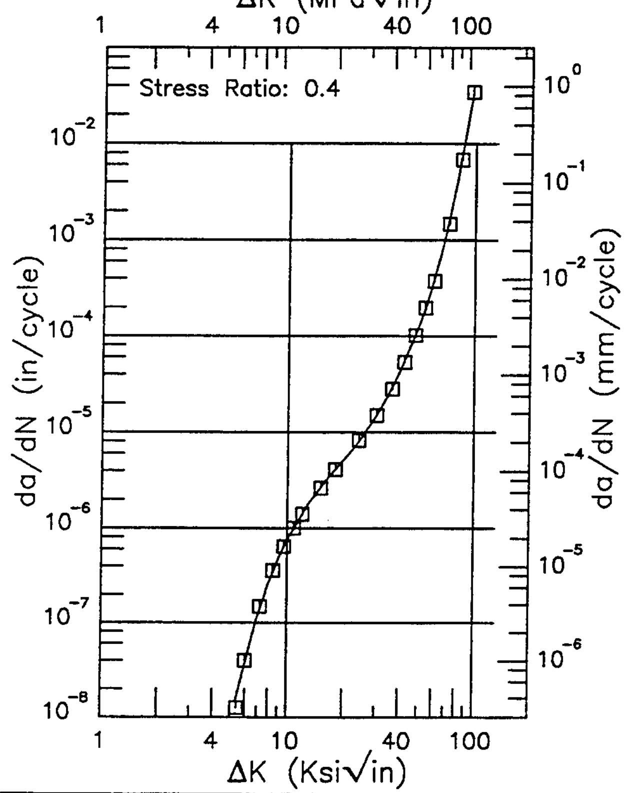
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.68 (min)	0.0151
8.	0.0223
9.	0.0617
10.	0.136
16.	1.52
20.	3.05
30.	7.95
40.	16.2
60.	69.6
80.	291.
100.	1127.
130.	9336.
153.60 (max)	52157.

RMS % Error: 6.92

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(4 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.40 (min)	0.0150
6.	0.0374
7.	0.117
8.	0.263
9.	0.479
10.	0.756
16.	3.10
20.	5.12
30.	14.6
40.	43.0
60.	368.
80.	4023.
96.00 (max)	33821.

RMS % Error: 4.68

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

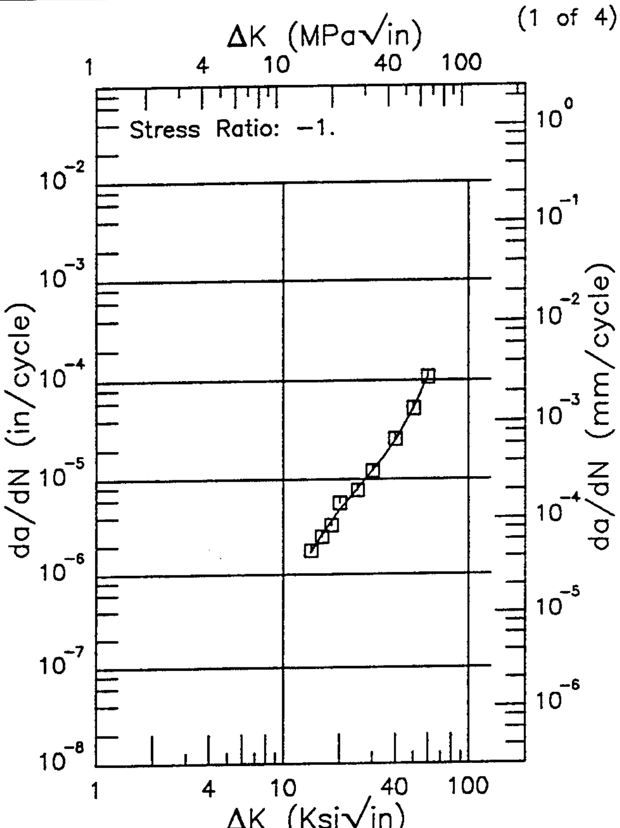
Figure 4.1.3.1.9 (Concluded)

R — 15-5PH

Condition/Ht: TUS=150-165KSI
Form: 0.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: S-L
Frequency:
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: BW004

(1 of 4)



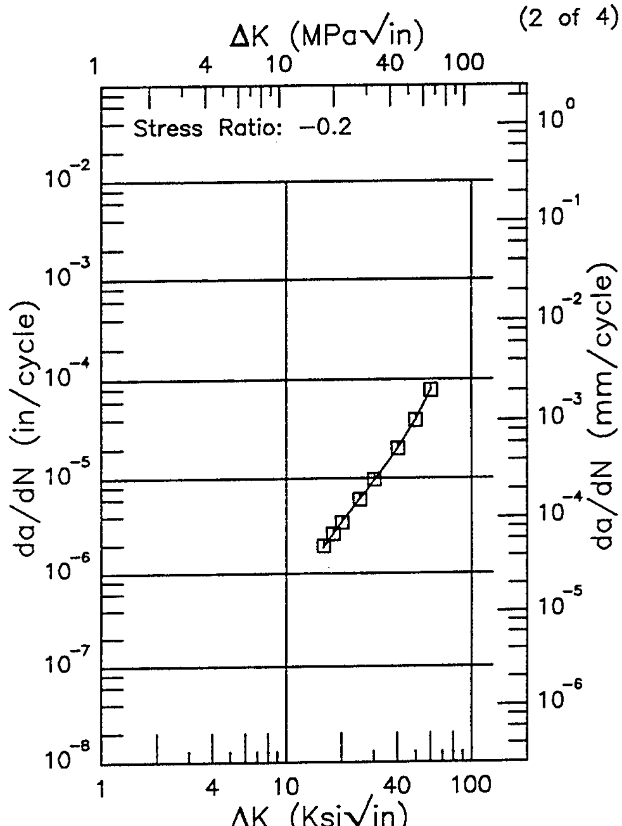
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.00 (min)	1.69
16.	2.61
20.	4.78
25.	8.05
30.	12.2
35.	17.7
40.	25.3
50.	51.6
60.00 (max)	108.

RMS % Error: 6.77

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.00 (min)	1.88
20.	3.46
25.	6.03
30.	9.42
35.	13.9
40.	20.0
50.	39.6
60.00 (max)	76.5

RMS % Error: 1.65

Life Prediction Ratio Summary

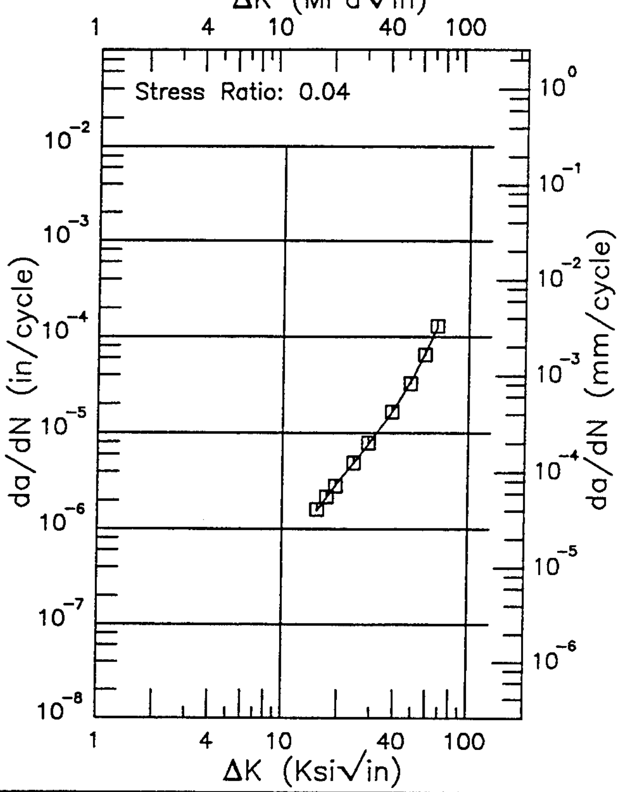
0. .5 .8 1.25 2.

Figure 4.1.3.1.10

Condition/Ht: TUS=150−165KSI
Form: 0.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: S−L
Frequency:
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: BW004

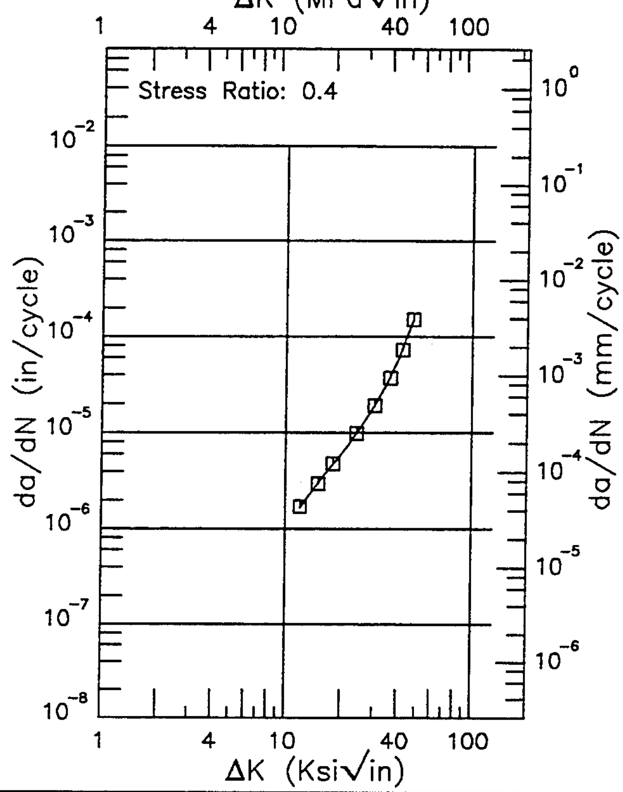
(3 of 4)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
15.36 (min)	1.56
16.	1.75
20.	3.16
25.	5.45
30.	8.51
35.	12.7
40.	18.5
50.	37.9
60.	76.5
67.20 (max)	126.

RMS % Error	Life Prediction Ratio Summary
1.65	0. .5 .8 1.25 2.

(4 of 4)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
12.00 (min)	1.66
13.	2.07
16.	3.52
20.	6.04
25.	10.8
30.	18.8
35.	32.9
40.	57.9
48.00 (max)	146.

RMS % Error	Life Prediction Ratio Summary
1.69	0. .5 .8 1.25 2.

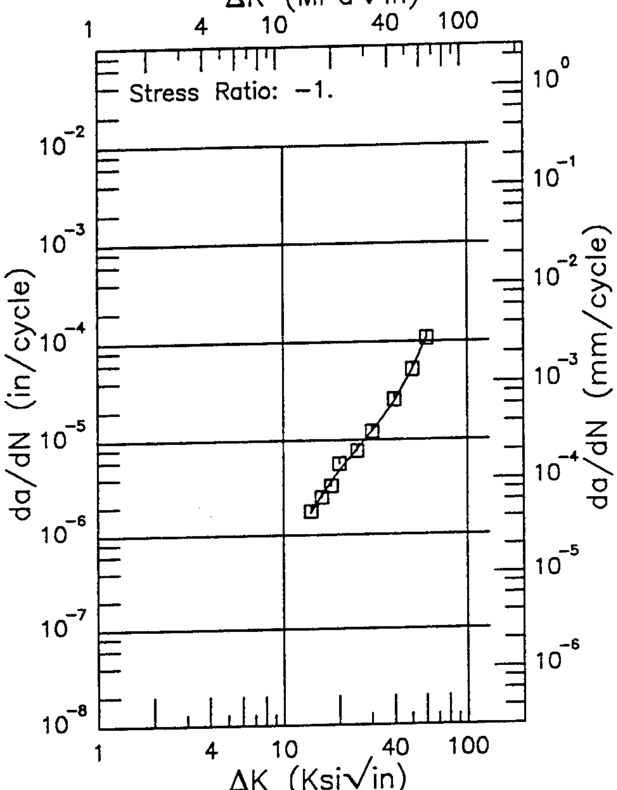
Figure 4.1.3.1.10 (Concluded)

R 15–5PH

Condition/Ht: TUS=150–165KSI
Form: 0.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: S–L
Frequency:
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: BW004

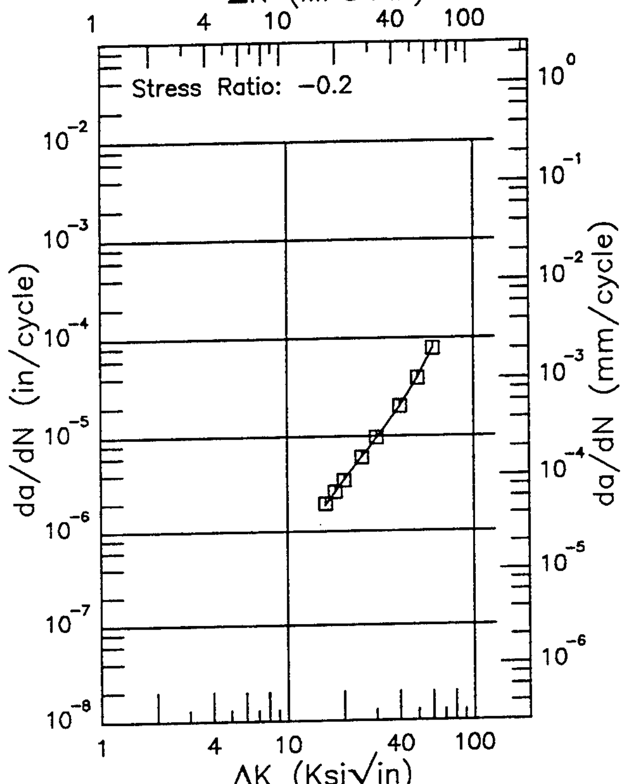
(1 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.00 (min)	1.69
16.	2.61
20.	4.78
25.	8.05
30.	12.2
35.	17.7
40.	25.3
50.	51.6
60.00 (max)	108.

RMS % Error	Life Prediction Ratio Summary
6.77	0. .5 .8 1.25 2.

(2 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.00 (min)	1.88
20.	3.46
25.	6.03
30.	9.42
35.	13.9
40.	20.0
50.	39.6
60.00 (max)	76.5

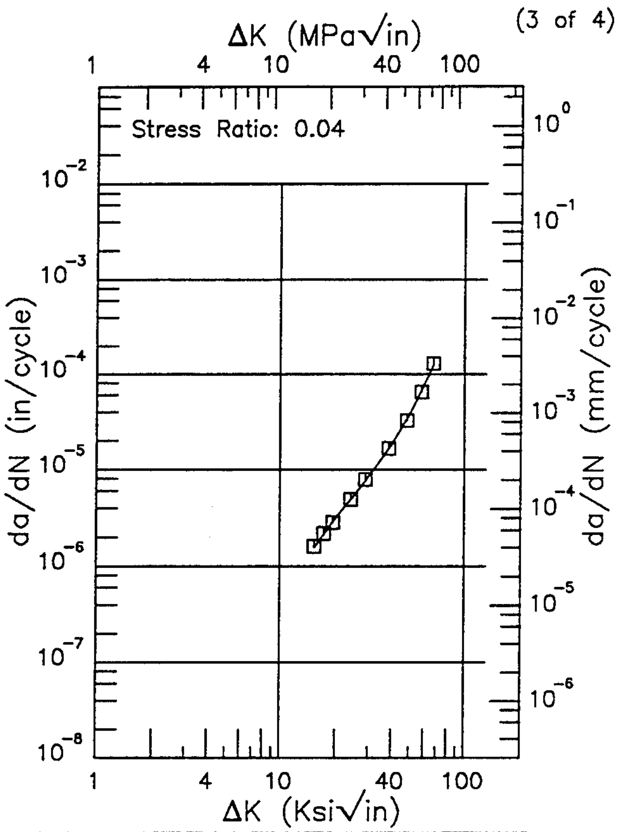
RMS % Error	Life Prediction Ratio Summary
1.65	0. .5 .8 1.25 2.

Figure 4.1.3.1.11

Condition/Ht: TUS=150–165KSI
Form: 0.5 in. Billet
Specimen Type: CCP (max load specified)
Orientation: S–L
Frequency:
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk:
Specimen Width:
Ref: BW004

(3 of 4)

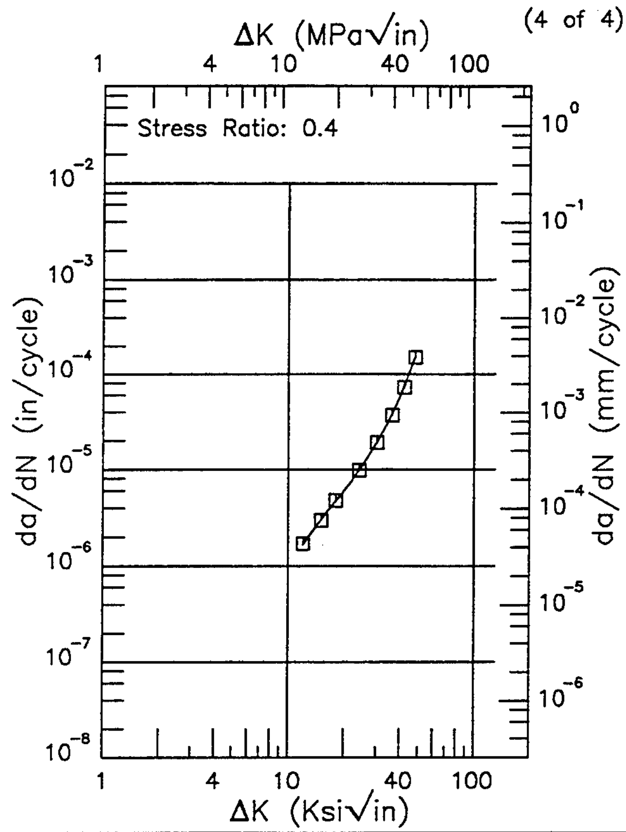


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.36 (min)	1.56
16.	1.75
20.	3.16
25.	5.45
30.	8.51
35.	12.7
40.	18.5
50.	37.9
60.	76.5
67.20 (max)	126.

RMS % Error: 1.65

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(4 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.00 (min)	1.66
13.	2.07
16.	3.52
20.	6.04
25.	10.8
30.	18.8
35.	32.9
40.	57.9
48.00 (max)	146.

RMS % Error: 1.69

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 4.1.3.1.11 (Concluded)

TABLE 4.1.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL 15-5PH

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
H900	B	R.T.	T-L	171.2	20% NaCl	CT	2	1	2.25	---	71.8	33	---	1973	86688
					Industrial Atm	CT	2	1	2.25	---	71.8	68	---	1973	86688
					Seacoast Atm	CT	2	1	2.25	---	71.8	36	---	1973	86688
H1150M	B	R.T.	T-L	93.1	20% NaCl	CT	2	1	2.25	---	75.7	72+	---	1973	86688
					Industrial Atm	CT	2	1	2.25	---	75.7	72+	---	1973	86688
					Seacoast Atm	CT	2	1	2.25	---	75.7	72+	---	1973	86688

+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 4.2.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL 15-5PH(AM)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
H900	F	R.T.	---	175	3.5% NaCl	CANT	1.5	0.48	3	---	96.8	80*	60000	1971	84333
H1000	F	R.T.	---	157.9	3.5% NaCl	CANT	1.5	0.48	3	---	114	114*	60000	1971	84333

* specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 4.3.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL 15-5PH(VM)

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
H900	F	R.T.	---	174.9	3.5% NaCl	CANT	1.5	0.48	4.5	---	74.5	55.8	48000	1971	84333
H1000	F	R.T.	---	157.6	3.5% NaCl	CANT	1.5	0.48	4.5	---	120	120^{+}	60000	1971	84333

$^{+}$ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 4.4.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 17-4PH AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
H 900	PLATE	0.08	20			0.31	3.41	53.01	

TABLE 4.4.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
17-4PH AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	ROUND BAR	0.1	30			0.06	2.04		
		0.1	30			0.06	2.01		
		0.5	10				5.88		
		0.5	10				5.88		
		0.5	30		0.04	0.51			
		0.5	30		0.03	0.51			

TABLE 4.4.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
17-4PH AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1025	CASTING	0.02	1			0.33	3.51		

TABLE 4.4.2.1

STAINLESS STEEL 17-4PH K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
H 975	Rolled Bar	3.25	R.T.	L-R	168.0	2.000	1.000	NB	1.000	0.63	84.60	---	---	---	84212
H1025	Round Bar	3.00	R.T.	T-L	175.3	1.990	0.503	CT	0.937	0.45	74.50	---	---	1979	DA001

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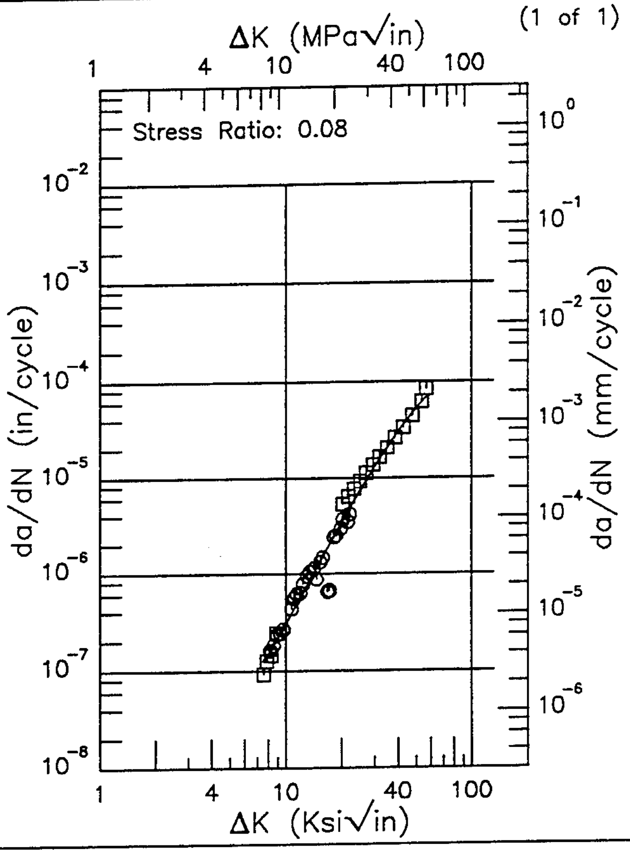
R

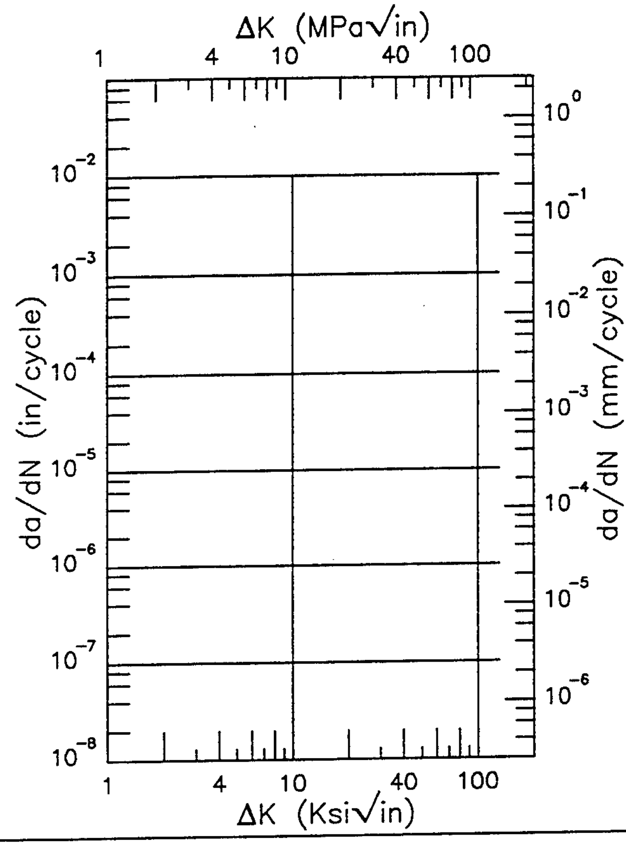
17–4PH

Condition/Ht: H 900
Form: 0.56 in. Plate
Specimen Type: CT
Orientation: L–T
Frequency: 20 Hz
Environment: LAB AIR; RT

Yield Strength: 170.5 ksi
Ult. Strength: 192.7 ksi
Specimen Thk: 0.5 in.
Specimen Width: 1.969 in.
Ref: DA001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
7.54 (min)	0.125
8.	0.150
9.	0.217
10.	0.306
13.	0.749
16.	1.56
20.	3.41
25.	7.30
30.	13.2
35.	21.0
40.	30.6
50.	53.0
56.40 (max)	68.2

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error
23.52

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

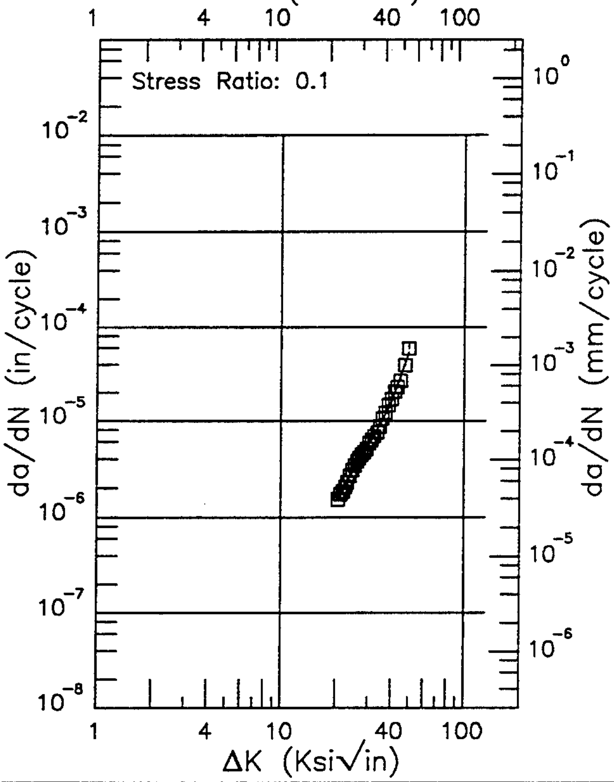
Life Prediction Ratio Summary
0. .5 .8 1.25 2.

Figure 4.4.3.1.1

Condition/Ht: H1025
Form: 3 in. Round Bar
Specimen Type: CT
Orientation: T–L
Frequency: 10 Hz
Environment: LAB AIR; RT

Yield Strength: 175.3 ksi
Ult. Strength: 179.8 ksi
Specimen Thk: 0.502 in.
Specimen Width: 1.985 – 2.002 in.
Ref: DA001

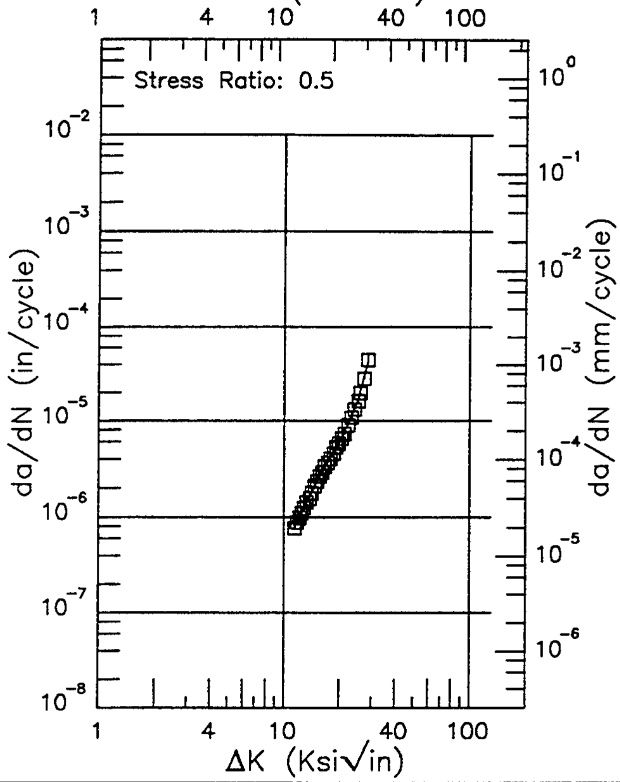
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
20.54 (min)	1.48
25.	3.15
30.	5.61
35.	9.33
40.	15.9
49.82 (max)	54.3

RMS % Error	Life Prediction Ratio Summary
4.80	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.39 (min)	0.756
13.	1.29
16.	2.78
20.	5.88
25.	15.8
28.37 (max)	43.2

RMS % Error	Life Prediction Ratio Summary
3.01	0. .5 .8 1.25 2.

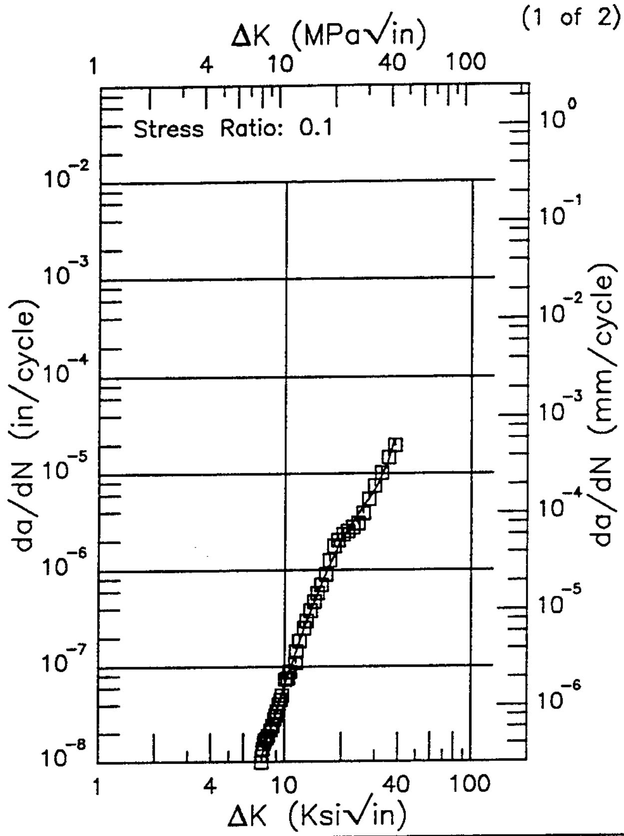
Figure 4.4.3.1.2

R — 17–4PH

Condition/Ht: H1025
Form: 3 in. Round Bar
Specimen Type: CT
Orientation: T–L
Frequency: 30 Hz
Environment: LAB AIR; RT

Yield Strength: 175.3 ksi
Ult. Strength: 179.8 ksi
Specimen Thk: 0.254 in.
Specimen Width: 1.991 – 2 in.
Ref: DA001

(1 of 2)



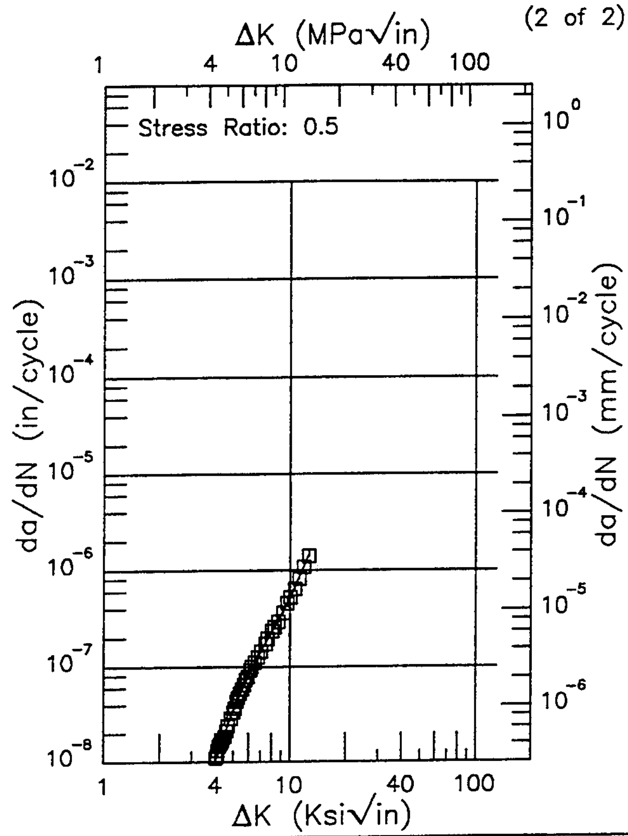
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.48 (min)	0.0110
8.	0.0167
9.	0.0345
10.	0.0650
13.	0.287
16.	0.810
20.	2.04
25.	4.06
30.	6.79
35.	12.9
38.39 (max)	22.6

RMS % Error: 9.60

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.00 (min)	0.00989
5.	0.0357
6.	0.0802
7.	0.143
8.	0.229
9.	0.347
10.	0.512
12.62 (max)	1.41

RMS % Error: 4.74

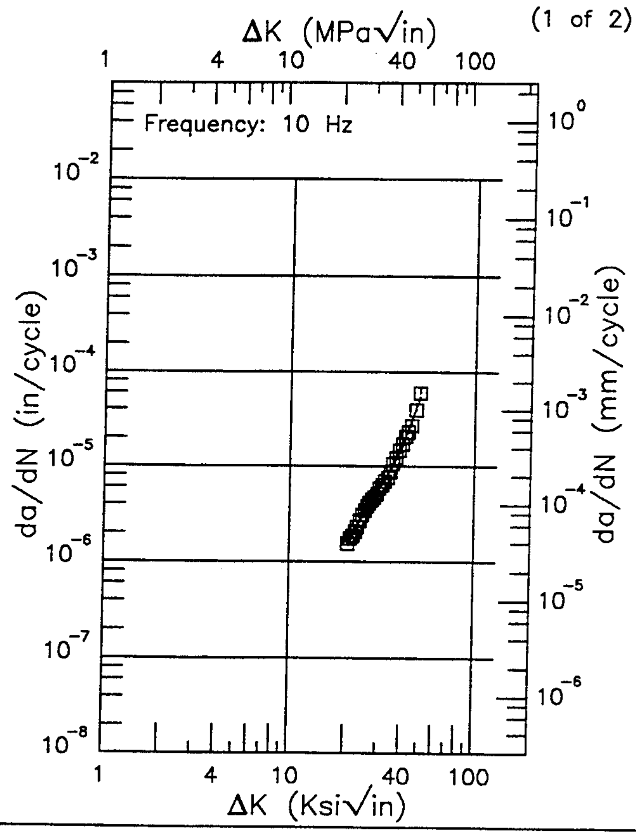
Life Prediction Ratio Summary

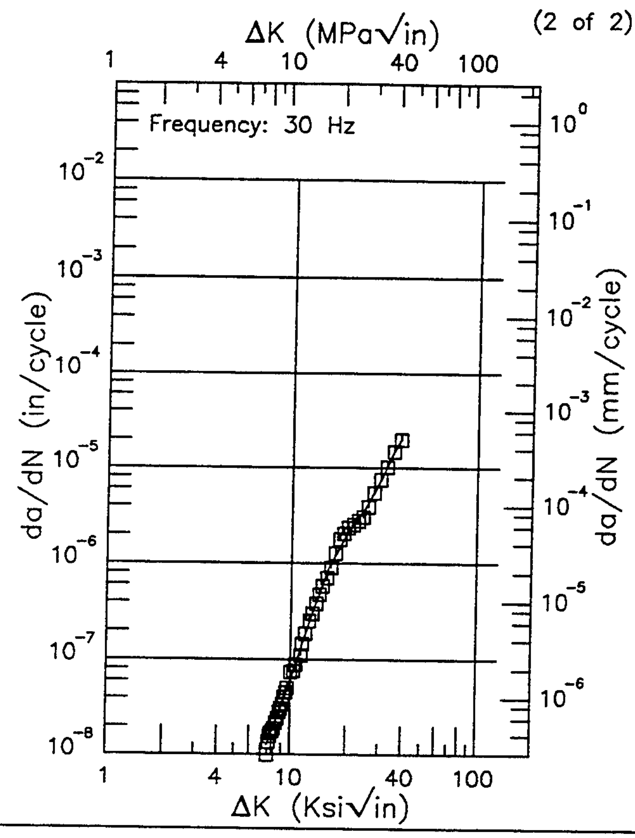
0. .5 .8 1.25 2.

Figure 4.4.3.1.3

Condition/Ht: H1025
Form: 3 in. Round Bar
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.1
Environment: LAB AIR; RT

Yield Strength: 175.3 ksi
Ult. Strength: 179.8 ksi
Specimen Thk: 0.254 – 0.502 in.
Specimen Width: 1.985 – 1.991 in.
Ref: DA001





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
20.54 (min)	1.48
25.	3.15
30.	5.61
35.	9.33
40.	15.9
49.82 (max)	54.3

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.48 (min)	0.0126
8.	0.0174
9.	0.0328
10.	0.0607
13.	0.294
16.	0.882
20.	2.01
25.	3.68
30.	7.14
35.	14.0
38.39 (max)	19.2

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
4.80	0. .5 .8 1.25 2.	8.45	0. .5 .8 1.25 2.

Figure 4.4.3.1.4

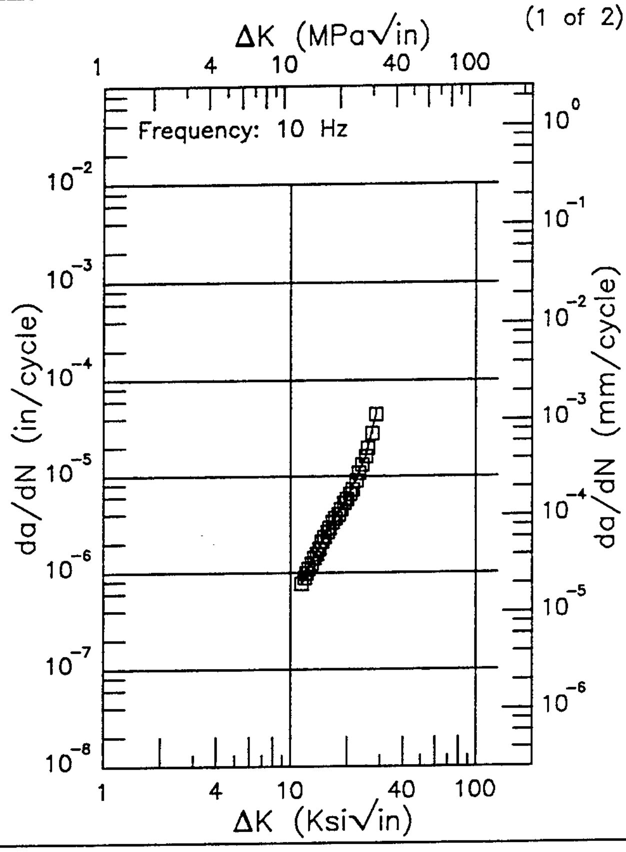
17-4PH

F

Condition/Ht: H1025
Form: 3 in. Round Bar
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.5
Environment: LAB AIR; RT

Yield Strength: 175.3 ksi
Ult. Strength: 179.8 ksi
Specimen Thk: 0.254 - 0.502 in.
Specimen Width: 2 - 2.002 in.
Ref: DA001

(1 of 2)



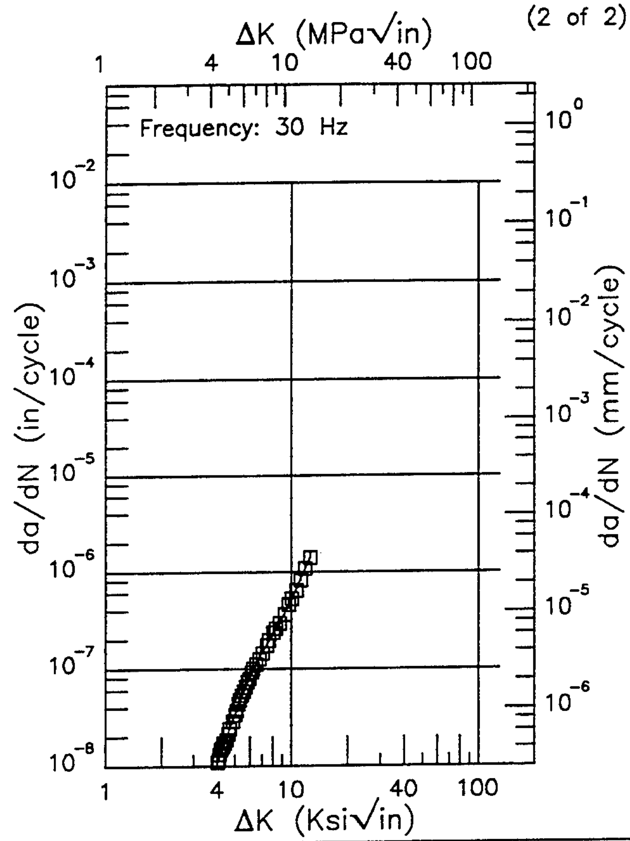
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.39 (min)	0.756
13.	1.29
16.	2.78
20.	5.88
25.	15.8
28.37 (max)	43.2

RMS % Error 3.01

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.00 (min)	0.0109
5.	0.0344
6.	0.0828
7.	0.147
8.	0.225
9.	0.338
10.	0.508
12.62 (max)	1.39

RMS % Error 2.92

Life Prediction Ratio Summary

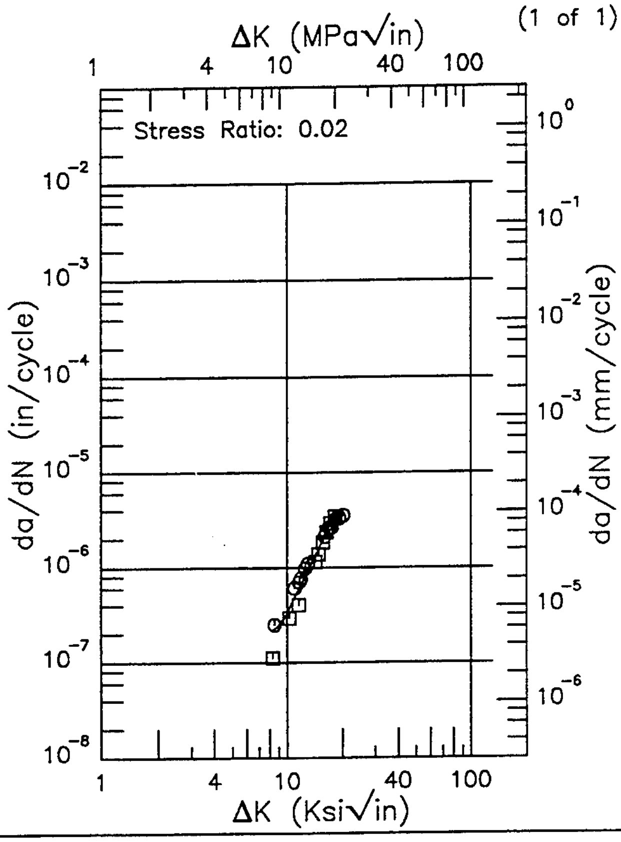
0. .5 .8 1.25 2.

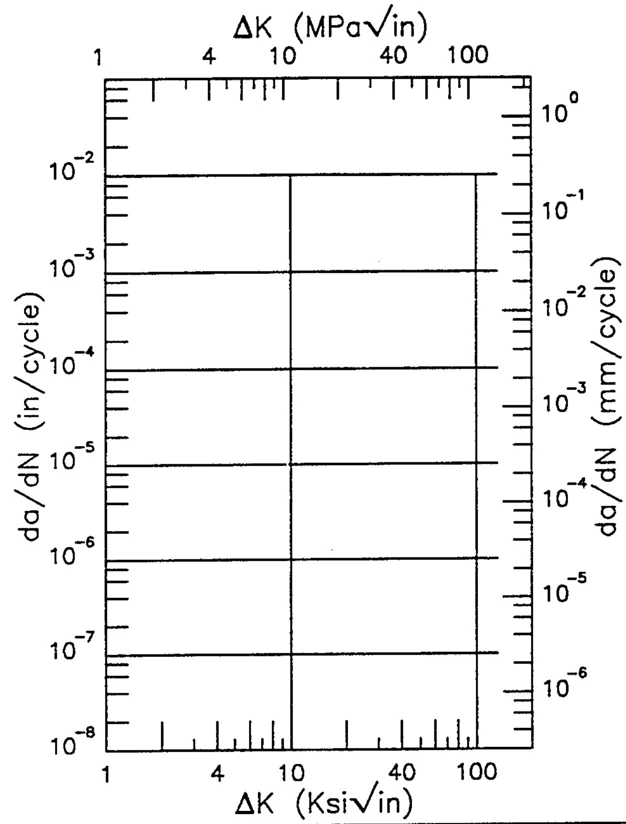
Figure 4.4.3.1.5

Condition/Ht: H1025
Form: Casting
Specimen Type: CCP (max load specified)
Orientation:
Frequency: 1 Hz
Environment: H.H.A.; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.103 – 0.113 in.
Specimen Width: 2.915 – 2.955 in.
Ref: GD010

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.33 (min)	0.214
9.	0.245
10.	0.330
13.	0.945
16.	2.15
20.	3.51
20.04 (max)	3.51

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
18.73

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.4.3.1.6

TABLE 4.4.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL 17-4PH

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
H900	B	R.T.	---	176.5	3.5% NaCl	CANT	1.5	0.48	1.75	---	51.5	51.5	60000	1971	84333
H1000	B	R.T.	---	157.9	3.5% NaCl	CANT	1.5	0.48	1.75	---	119	119+	60000	1971	84333

+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 4.5.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR STAINLESS STEEL ALLOY 17-7PH AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Rolled Bar	RH1050	---	---	---	47.	0.7	3	---	---	---

TABLE 4.5.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 17-7PH AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi$\sqrt{in}$*)					
				2.5	5.0	10.0	20.0	50.0	100.0
TH1050	PLATE	0.1	20		0.03	0.45			

TABLE 4.5.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 17-7PH AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
TH1050	PLATE	0.1	20		0.02	0.38	4.59		

TABLE 4.5.2.1

STAINLESS STEEL 17-7PH K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 * (K_Q/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
RH1050	Rolled Bar	1.25	R.T.	T-L	190.0	2.000	1.000	CT	1.026	0.15	47.10	47.0	0.7	1973	86688
		1.25			190.0	2.000	1.000	CT	1.025	0.15	47.70			1973	86688
		1.25			190.0	2.000	1.000	CT	1.066	0.15	46.30			1973	86688

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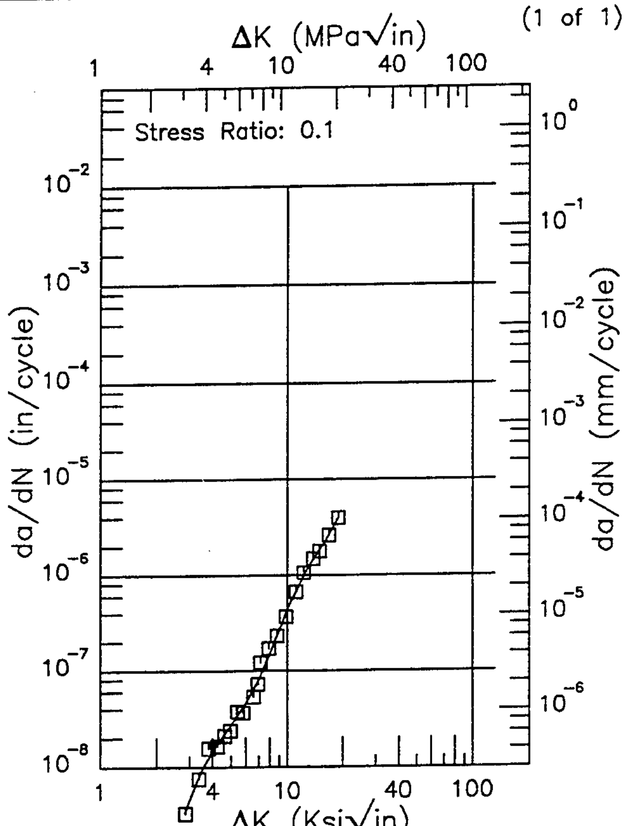
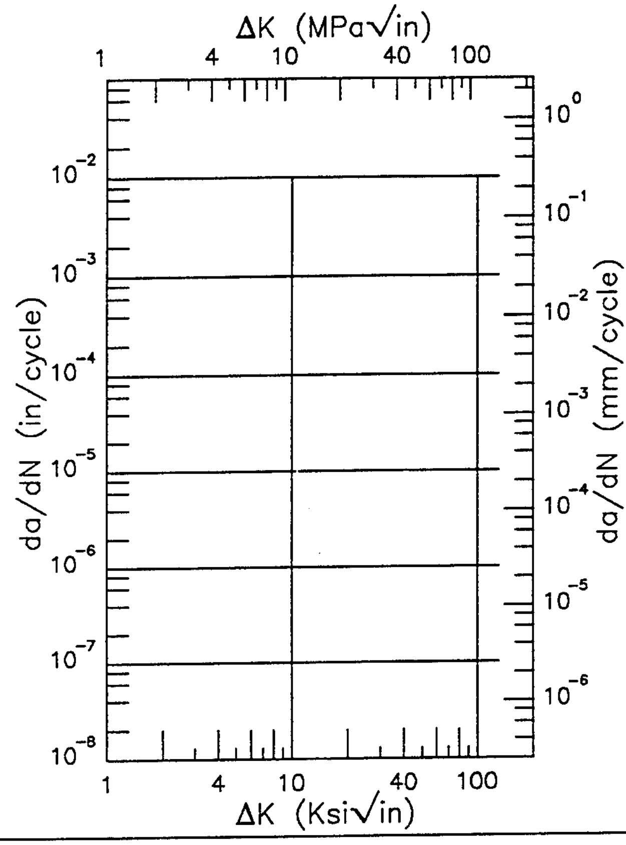
R 17-7PH

Condition/Ht: TH1050
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: L-T
Frequency: 20 Hz
Environment: LAB AIR; RT

Yield Strength: 194 ksi
Ult. Strength: 208.1 ksi
Specimen Thk: 0.5 in.
Specimen Width: 1.969 in.
Ref: DA001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
2.85 (min)	0.00339
3.	0.00454
4.	0.00922
4.	0.0146
5.	0.0272
6.	0.0457
7.	0.0805
8.	0.149
9.	0.268
10.	0.446
13.	1.22
16.	2.28
18.70 (max)	3.93

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error
13.33

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

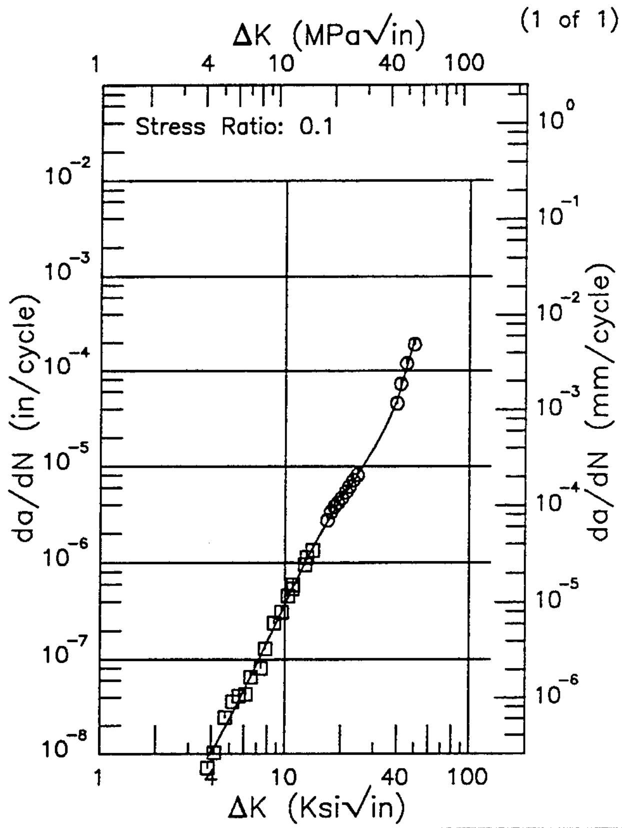
Life Prediction Ratio Summary
0. .5 .8 1.25 2.

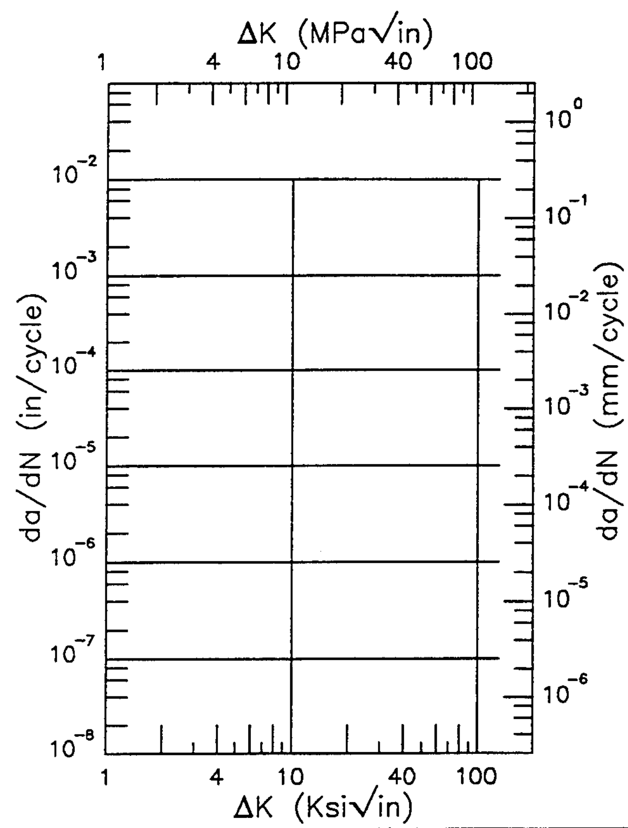
Figure 4.5.3.1.1

Condition/Ht: TH1050
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: T-L
Frequency: 20 Hz
Environment: LAB AIR; RT

Yield Strength: 190.3 ksi
Ult. Strength: 203.3 ksi
Specimen Thk: 0.5 in.
Specimen Width: 1.969 in.
Ref: DA001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.82 (min)	0.00900
4.	0.0105
5.	0.0236
6.	0.0478
7.	0.0886
8.	0.152
9.	0.246
10.	0.377
13.	1.05
16.	2.23
20.	4.59
25.	8.81
30.	15.5
35.	27.1
40.	49.3
49.65 (max)	213.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
12.16	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.5.3.1.2

TABLE 4.5.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL 17-7PH

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
RH950	B	R.T.	---	171.3	3.5% NaCl	CANT	1.5	0.48	1.75	---	32.3	<19	42000	1971	84333
RH1050	B	R.T.	T-L	190.5	20% NaCl	CT	2	1	1.25	---	47	10	---	1973	86688
					Industrial Atm	CT	2	1	1.25	---	47	24	---	1973	86688
					Seacoast Atm	CT	2	1	1.25	---	47	12	---	1973	86688
TH1050	B	R.T.	---	---	3.5% NaCl	CANT	1.5	0.48	1.75	---	38.7	15.8	30000	1971	84333

TABLE 4.6.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 21-6-9 NI40 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	SHEET	0.01				0.34	2.35	57.29	
		0.1				0.56	3.56	78.59	
		0.2				0.4	3.95	71.4	

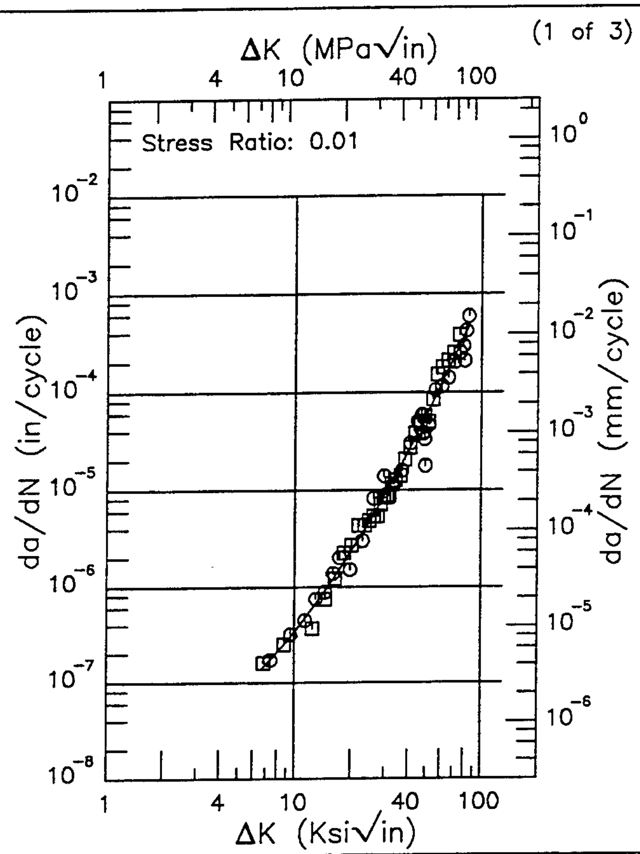
R

21-6-9 NI40

Condition/Ht: ANNEALED
Form: 0.03 in. Sheet
Specimen Type: CCP (max load specified)
Orientation: T-L
Frequency:
Environment: LAB AIR; RT

Yield Strength: 60 ksi
Ult. Strength: 100 ksi
Specimen Thk: 0.026 – 0.027 in.
Specimen Width: 2.308 – 2.309 in.
Ref: GD012

(1 of 3)

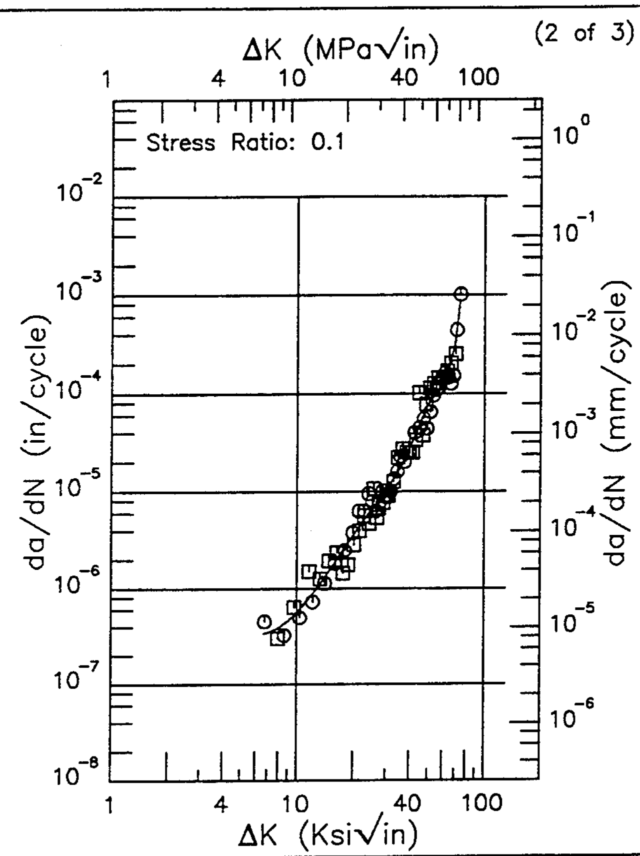


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.80 (min)	0.145
7.	0.154
8.	0.204
9.	0.266
10.	0.341
13.	0.669
16.	1.20
20.	2.35
25.	4.81
30.	8.91
35.	15.3
40.	24.8
50.	57.3
60.	116.
70.	215.
80.	369.
84.57 (max)	464.

RMS % Error: 24.49

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.73 (min)	0.339
7.	0.344
8.	0.387
9.	0.458
10.	0.558
13.	1.05
16.	1.87
20.	3.56
25.	6.47
30.	10.3
35.	16.4
40.	27.6
50.	78.6
60.	124.
70.	313.
73.97 (max)	879.

RMS % Error: 29.10

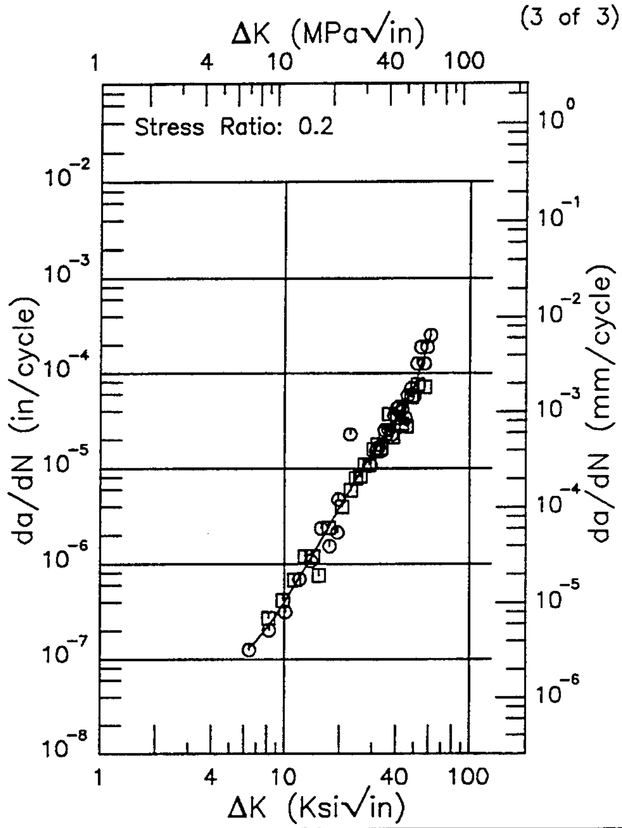
Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

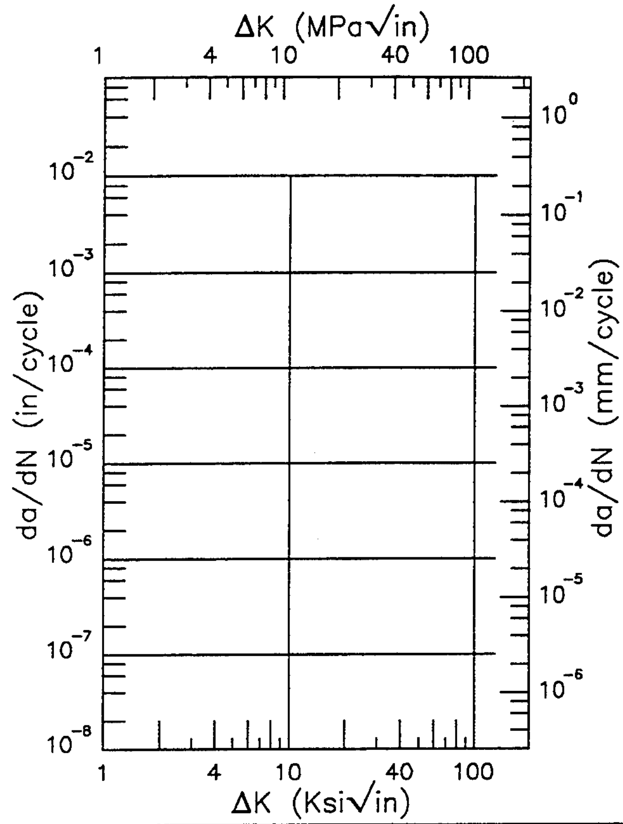
Figure 4.6.3.1

Condition/Ht: ANNEALED
Form: 0.03 in. Sheet
Specimen Type: CCP (max load specified)
Orientation: T-L
Frequency:
Environment: LAB AIR; RT

Yield Strength: 60 ksi
Ult. Strength: 100 ksi
Specimen Thk: 0.026 – 0.027 in.
Specimen Width: 2.308 – 2.309 in.
Ref: GD012

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.40 (min)	0.131
7.	0.157
8.	0.214
9.	0.292
10.	0.396
13.	0.908
16.	1.84
20.	3.95
25.	8.28
30.	14.5
35.	22.3
40.	31.9
50.	71.4
60.	215.
61.23 (max)	251.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
45.10	○ □ 0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.6.3.1 (Concluded)

TABLE 4.7.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 304 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi*$\sqrt{in}$) 2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	PLATE	0.	0.03					55.99	
		0.	6.67				1.95	27.99	

TABLE 4.7.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
304 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) *ΔK Level (Ksi√in)*					
				2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	PLATE	0.	6.67				1.86	32.46	

TABLE 4.7.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 304 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	SHEET	0.05	10			0.2	3.06		
		0.05	15			0.13	2.83		
		0.05	10-15			0.14	3.09		
		0.1	1.67				2.82		
		0.1	1.67-6				2.59		
		0.1	6				2.76		
ANNEALED & AGED	PLATE	0.05	3				1.39		

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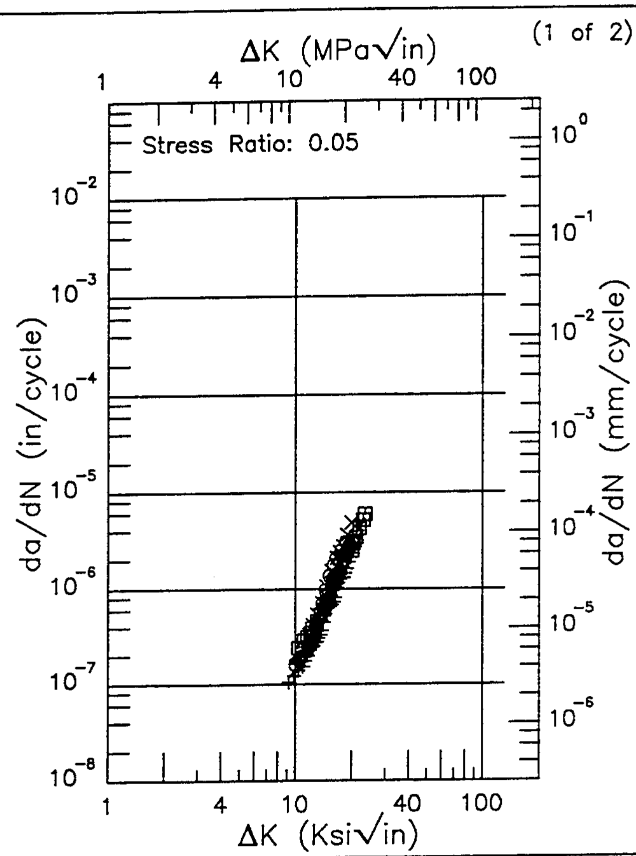
R — 304

Condition/Ht: ANNEALED
Form: Sheet
Specimen Type: CCP (max load specified)
Orientation:
Frequency: 1.7 – 15 Hz
Environment: LAB AIR; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.01 – 0.018 in.
Specimen Width: 0.995 – 2 in.
Ref: HD009

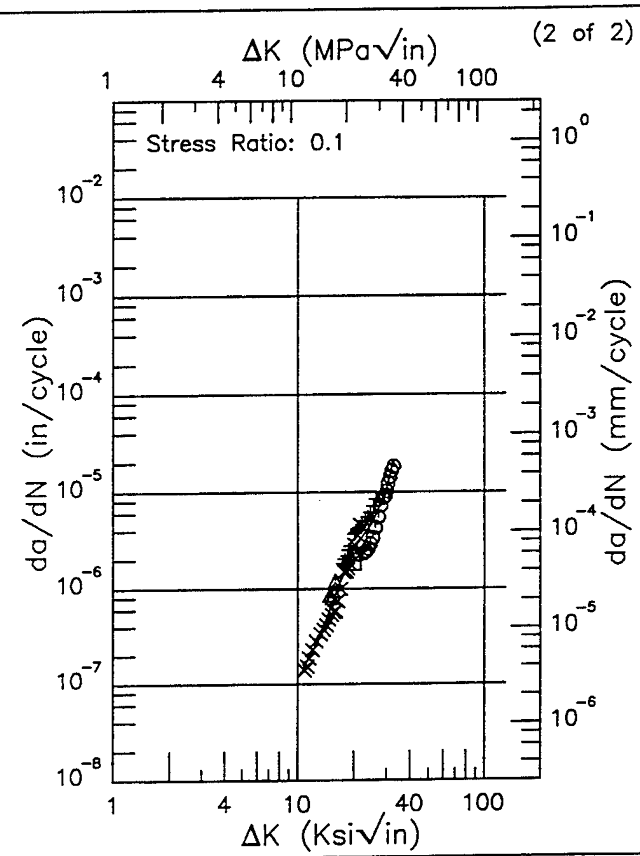


ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
9.16 (min)	0.112
10.	0.144
13.	0.416
16.	1.13
20.	3.09
23.49 (max)	5.35

RMS % Error: 24.35

Life Prediction Ratio Summary

0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
10.85 (min)	0.154
13.	0.299
16.	0.877
20.	2.59
25.	4.75
30.	10.3
32.52 (max)	21.3

RMS % Error: 26.42

Life Prediction Ratio Summary

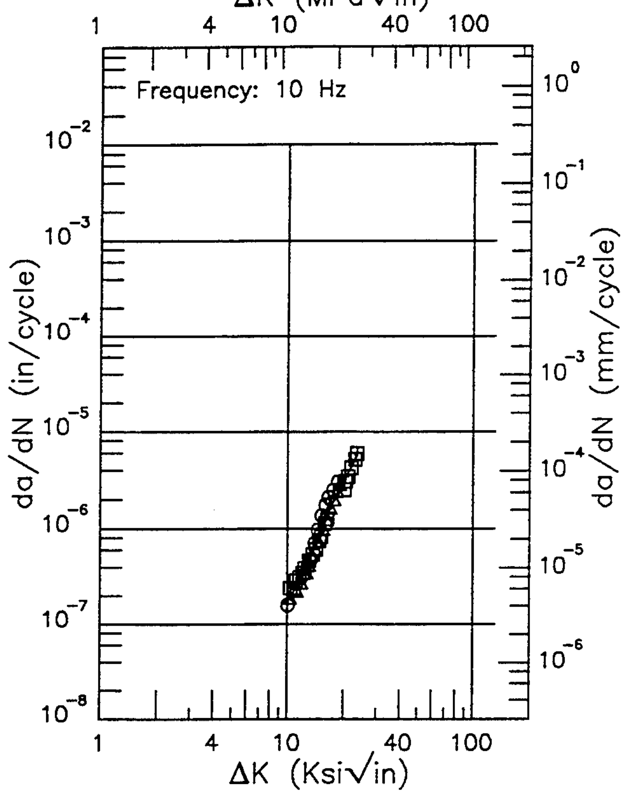
0. .5 .8 1.25 2.

Figure 4.7.3.1.1

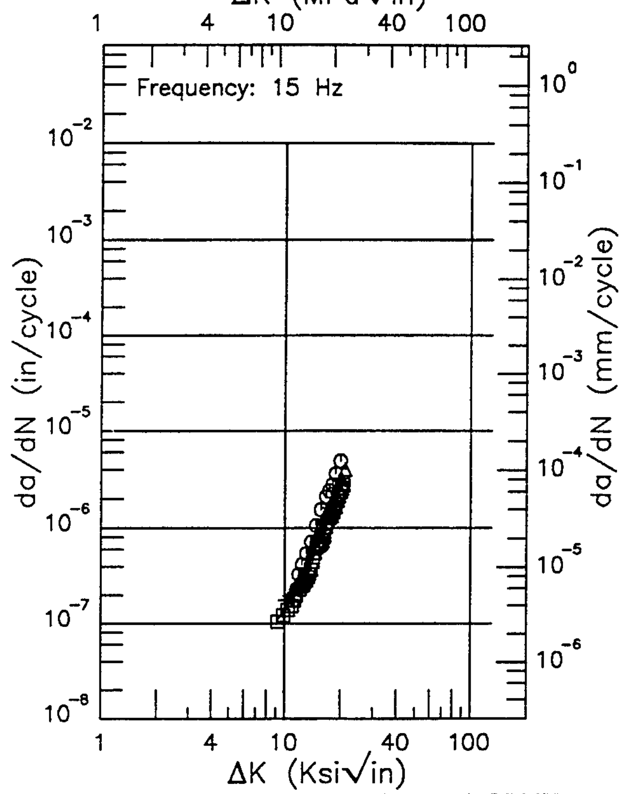
Condition/Ht: ANNEALED
Form: Sheet
Specimen Type: CCP (max load specified)
Orientation:
Stress Ratio: 0.05
Environment: LAB AIR; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.018 in.
Specimen Width: 0.995 – 1.998 in.
Ref: HD009

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.98 (min)	0.200
10.	0.200
13.	0.454
16.	1.36
20.	3.06
23.49 (max)	5.62

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.16 (min)	0.112
10.	0.133
13.	0.360
16.	1.01
20.	2.83
21.04 (max)	3.45

RMS % Error	Life Prediction Ratio Summary
15.52	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
28.53	0. .5 .8 1.25 2.

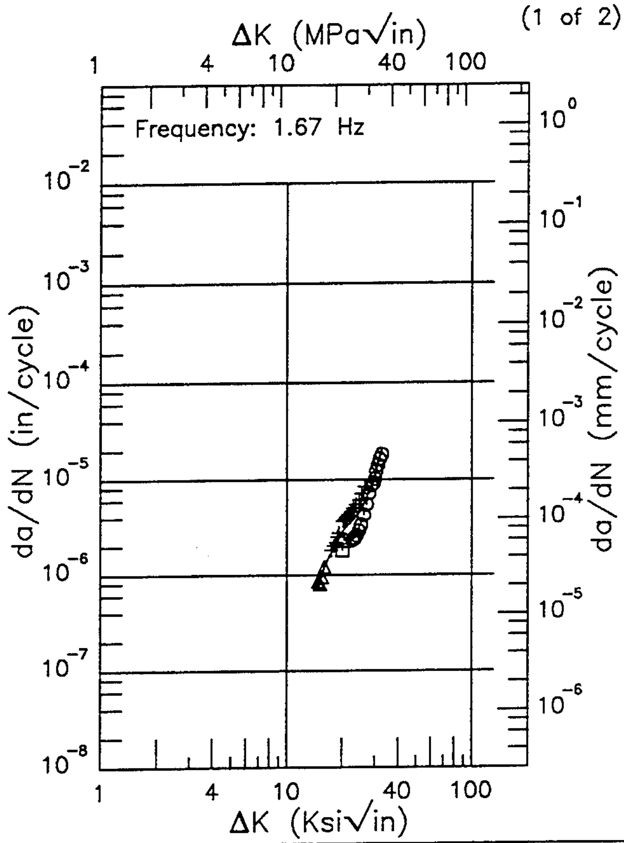
Figure 4.7.3.1.2

F

Condition/Ht: ANNEALED
Form: Sheet
Specimen Type: CCP (max load specified)
Orientation:
Stress Ratio: 0.1
Environment: LAB AIR; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 0.01 in.
Specimen Width: 2 in.
Ref: HD009

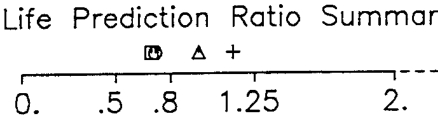
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.71 (min)	0.693
16.	1.24
20.	2.82
25.	4.64
30.	10.6
32.52 (max)	19.9

RMS % Error 24.36

Life Prediction Ratio Summary



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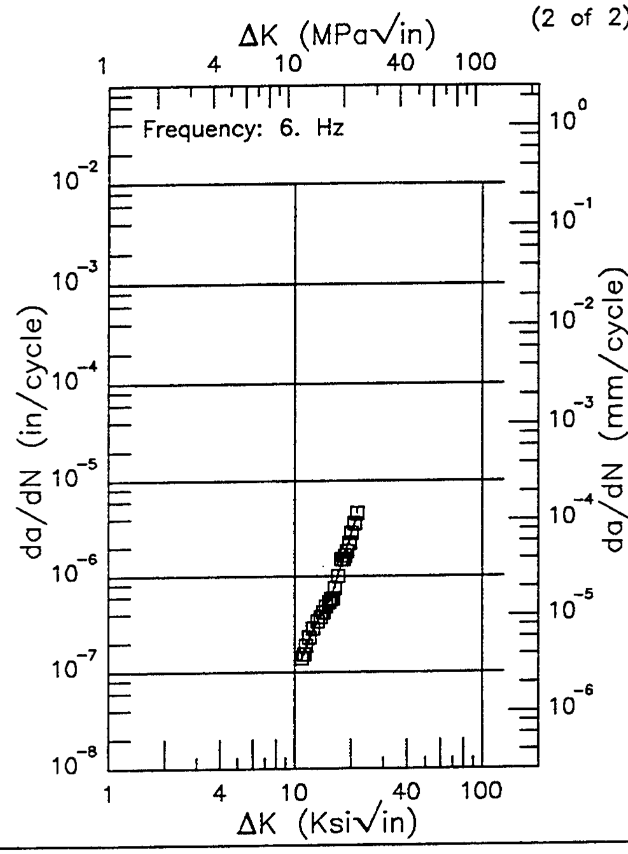


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.85 (min)	0.132
13.	0.310
16.	0.667
20.	2.76
21.51 (max)	4.22

RMS % Error 6.84

Life Prediction Ratio Summary

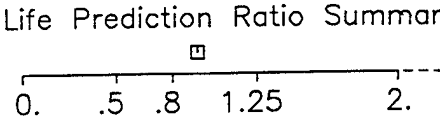
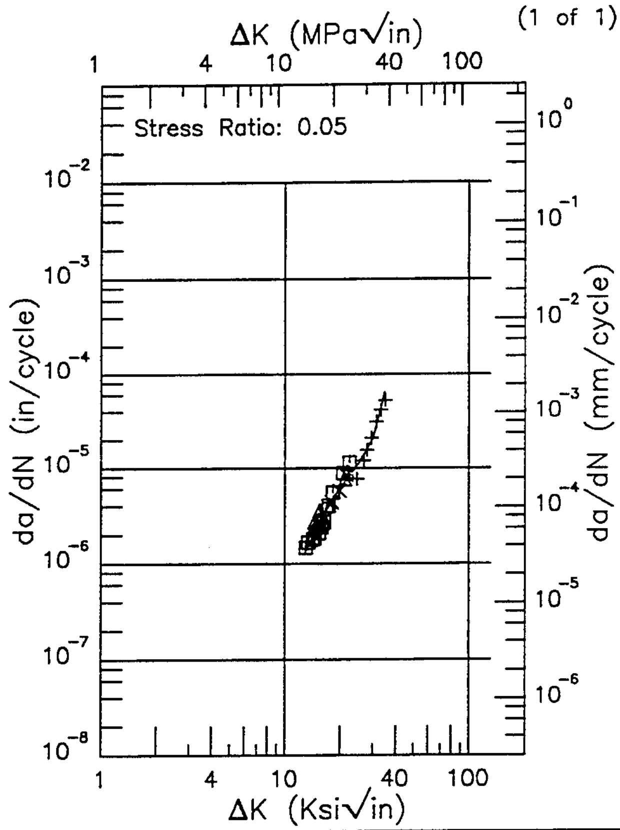


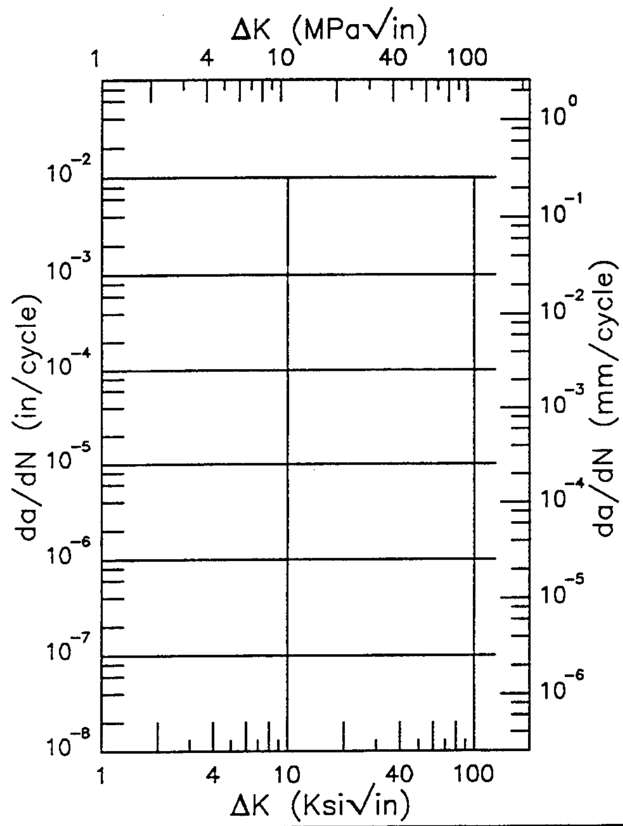
Figure 4.7.3.1.3

Condition/Ht: ANNEALED
Form: 0.5 in. Plate
Specimen Type: CT
Orientation:
Frequency: 0.7 Hz
Environment: LAB AIR;800°F

Yield Strength: 39.6 ksi
Ult. Strength: 77.5 ksi
Specimen Thk: 0.3 – 0.5 in.
Specimen Width: 1.157 – 2.998 in.
Ref: HD011;HD012

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.99 (min)	1.31
13.	1.31
16.	3.05
20.	6.25
25.	11.0
30.	20.6
34.83 (max)	64.2

ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
16.99	+○K Δ 0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

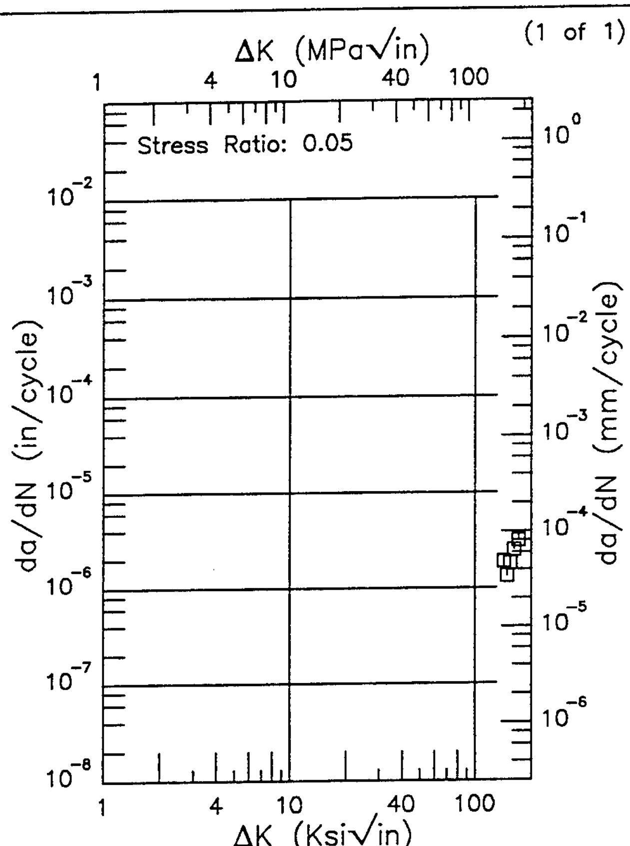
Figure 4.7.3.1.4

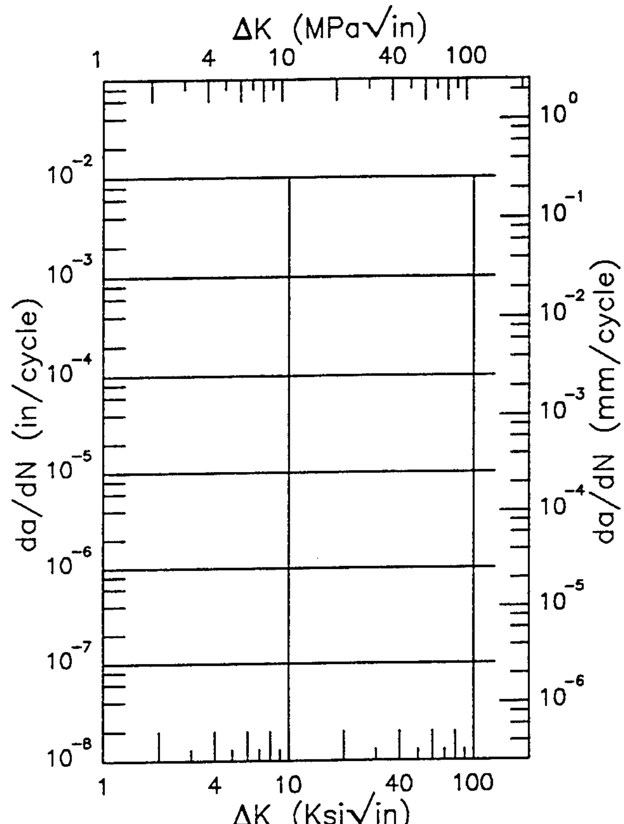
R 304

Condition/Ht: ANNEALED
Form: 0.5 in. Plate
Specimen Type: CT
Orientation: L–T
Frequency: 1 Hz
Environment: LAB AIR; RT

Yield Strength: 39.6 ksi
Ult. Strength: 77.1 ksi
Specimen Thk: 0.494 in.
Specimen Width: 2 in.
Ref: HD007

(1 of 1)





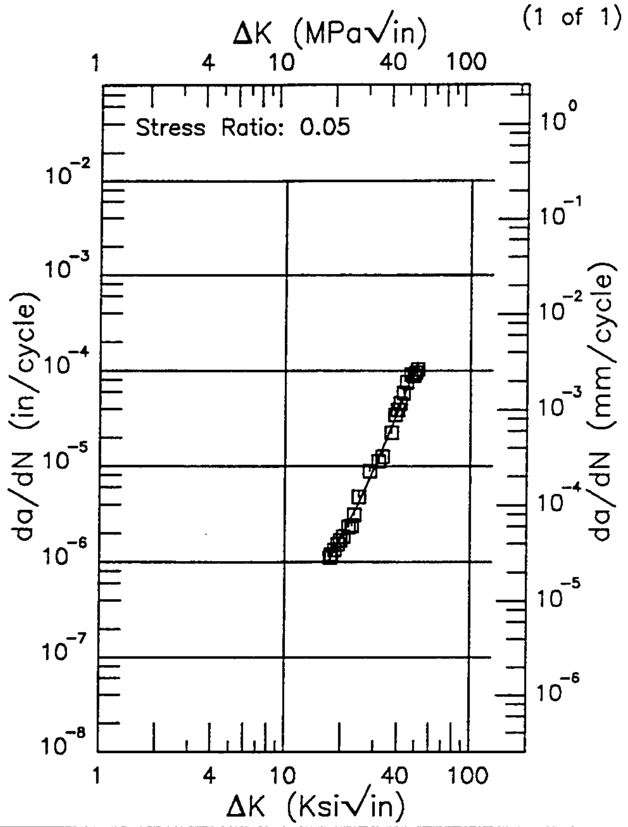
ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)	ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

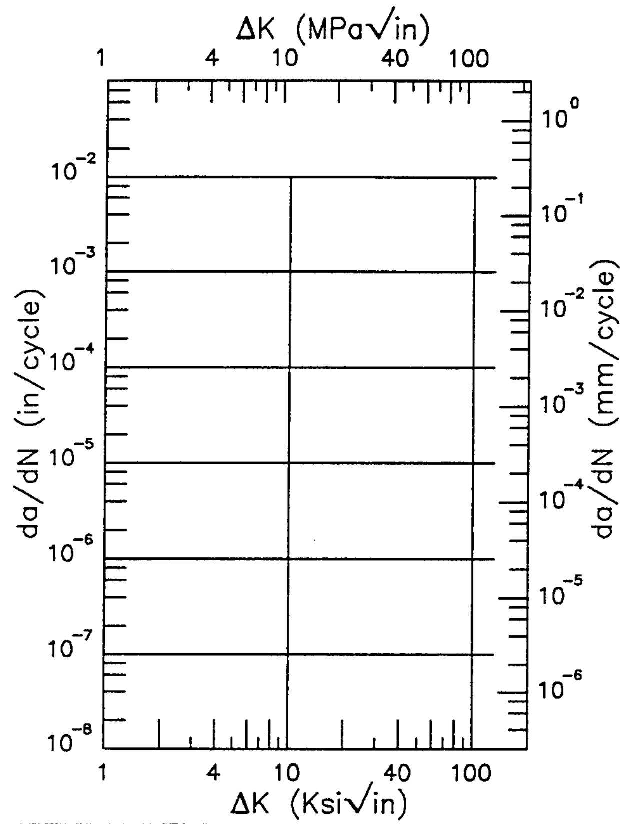
RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.		0. .5 .8 1.25 2.

Figure 4.7.3.1.5

Condition/Ht: ANNEALED	
Form: 1 in. Plate	Yield Strength: 39 ksi
Specimen Type: CT	Ult. Strength: 84 ksi
Orientation: T–L	Specimen Thk: 0.999 in.
Frequency: 2.5 Hz	Specimen Width: 8.001 in.
Environment: LAB AIR;550°F	Ref: HD010

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.34 (min)	1.06
20.	1.78
25.	4.38
30.	9.77
35.	19.9
40.	37.6
50.	110.
51.20 (max)	123.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
11.21	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

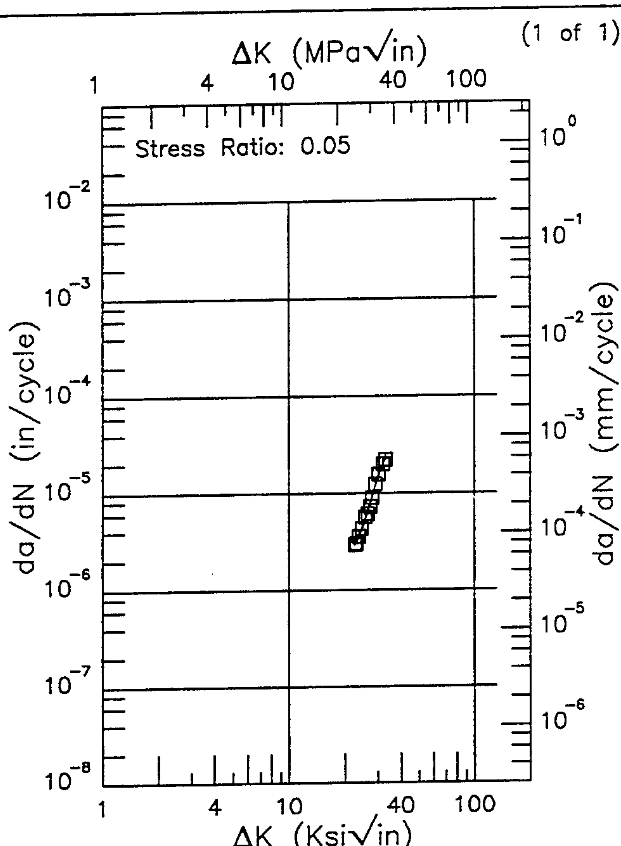
Figure 4.7.3.1.6

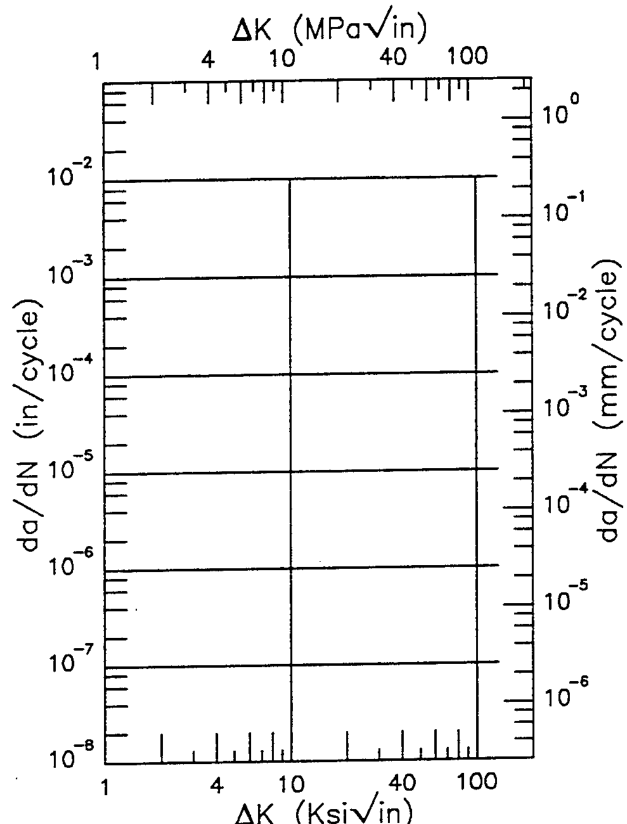
R 304

Condition/Ht: ANNEALED
Form: 1 in. Plate
Specimen Type: CT
Orientation: T–L
Frequency: 2.5 Hz
Environment: LAB AIR;550°F

Yield Strength: 39 ksi
Ult. Strength: 84 ksi
Specimen Thk: 0.252 in.
Specimen Width: 1.999 in.
Ref: HD010

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
22.49 (min)	2.94
25.	4.63
30.	14.8
32.81 (max)	22.4

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

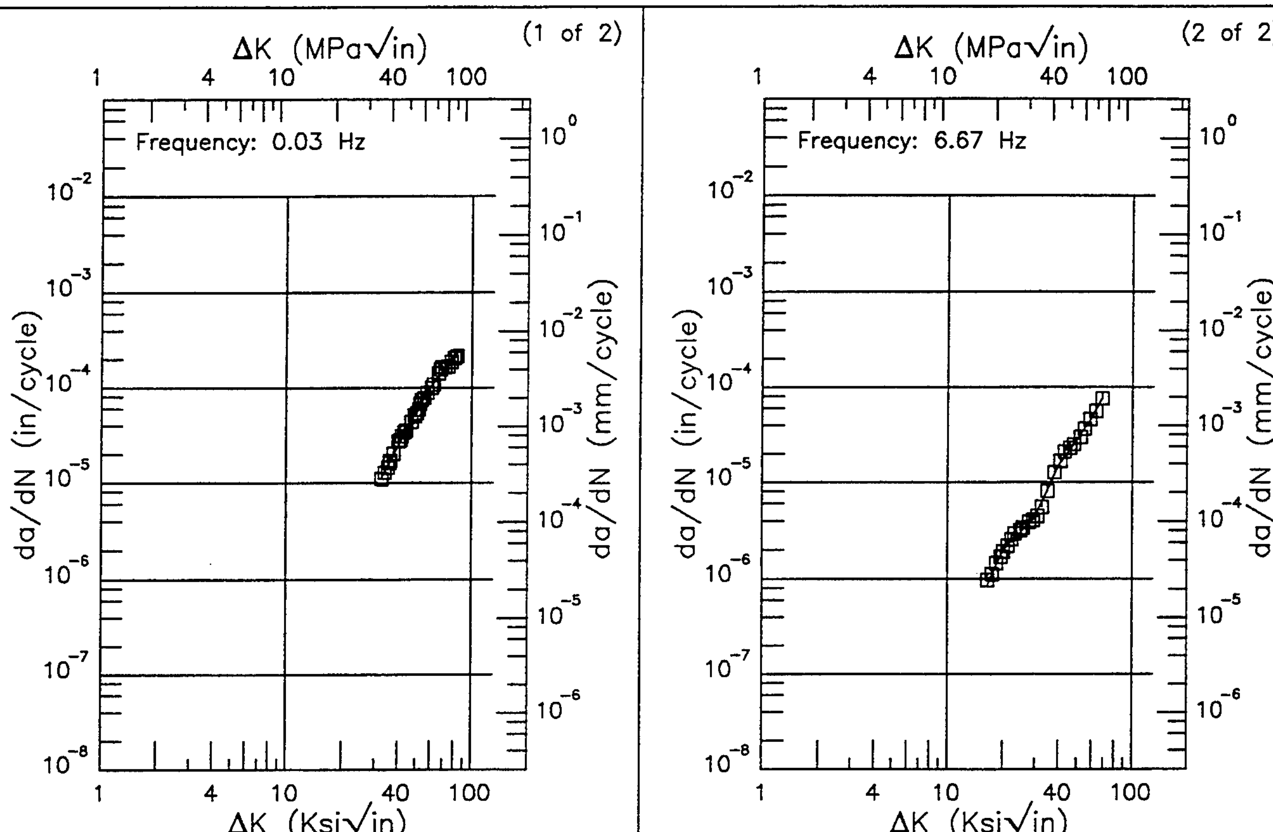
RMS % Error	Life Prediction Ratio Summary
5.36	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.7.3.1.7

Condition/Ht: ANNEALED
Form: 0.5 in. Plate
Specimen Type: SENT
Orientation: L–T
Stress Ratio: 0.
Environment: LAB AIR; RT

Yield Strength: 39.6 ksi
Ult. Strength: 77.1 ksi
Specimen Thk: 0.491 in.
Specimen Width: 4.91 – 4.95 in.
Ref: HD007



(1 of 2)

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
32.53 (min)	11.1
35.	14.7
40.	24.7
50.	56.0
60.	101.
70.	154.
80.	205.
82.69 (max)	217.

RMS % Error: 5.20

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 2)

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.50 (min)	0.831
20.	1.95
25.	2.98
30.	4.53
35.	8.47
40.	15.0
50.	28.0
60.	47.1
68.22 (max)	74.8

RMS % Error: 6.74

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

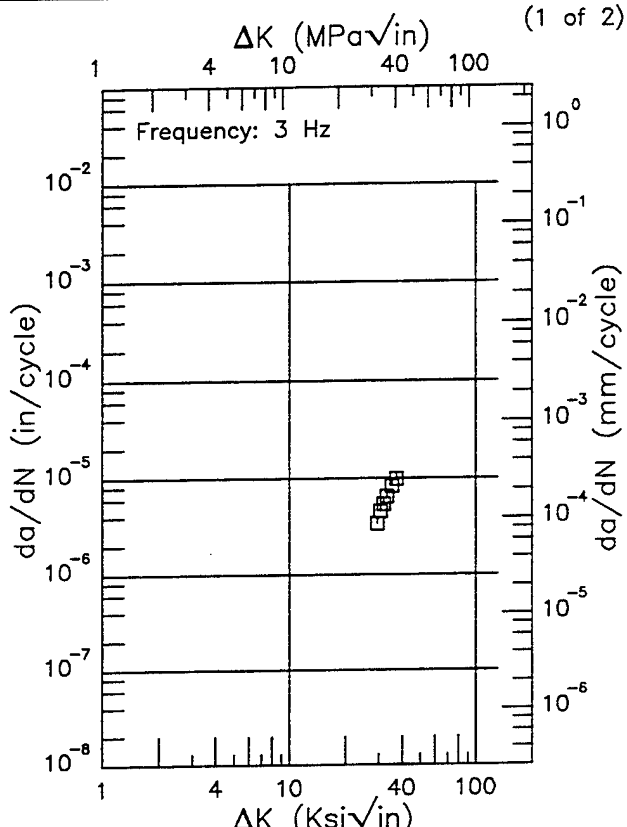
Figure 4.7.3.1.8

304 F

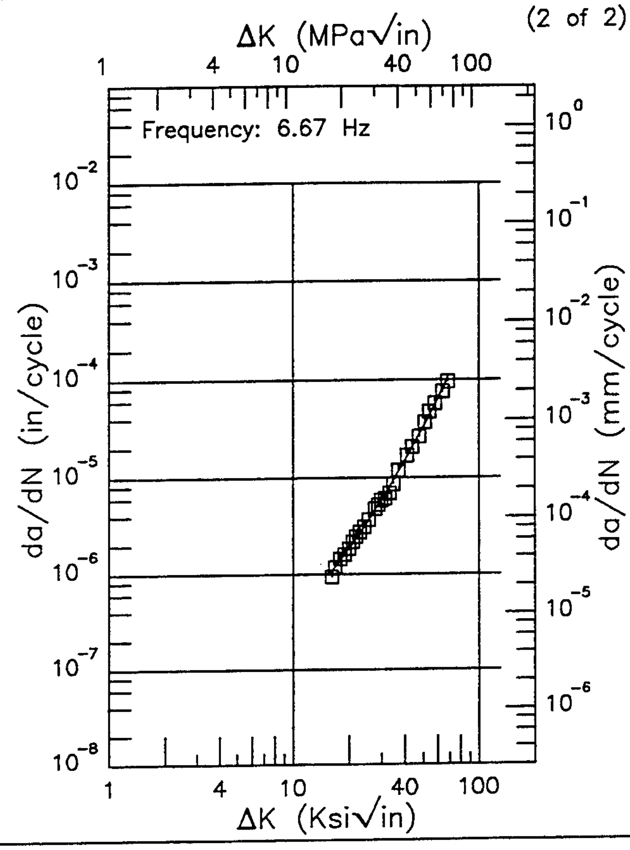
Condition/Ht: ANNEALED
Form: 0.5 in. Plate
Specimen Type: SENT
Orientation: T-L
Stress Ratio: 0.
Environment: LAB AIR; RT

Yield Strength: 39.6 ksi
Ult. Strength: 77.1 ksi
Specimen Thk: 0.493 – 0.496 in.
Specimen Width: 4.91 – 4.915 in.
Ref: HD007

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
16.13 (min)	1.09
20.	1.86
25.	3.44
30.	5.93
35.	9.64
40.	15.0
50.	32.5
60.	63.2
67.92 (max)	101.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

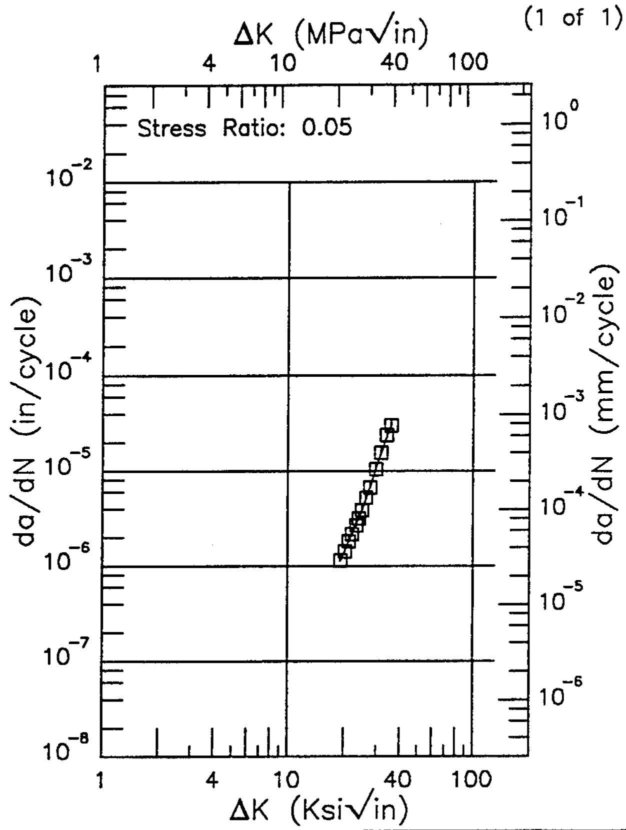
RMS % Error	Life Prediction Ratio Summary
5.77	0. .5 .8 1.25 2.

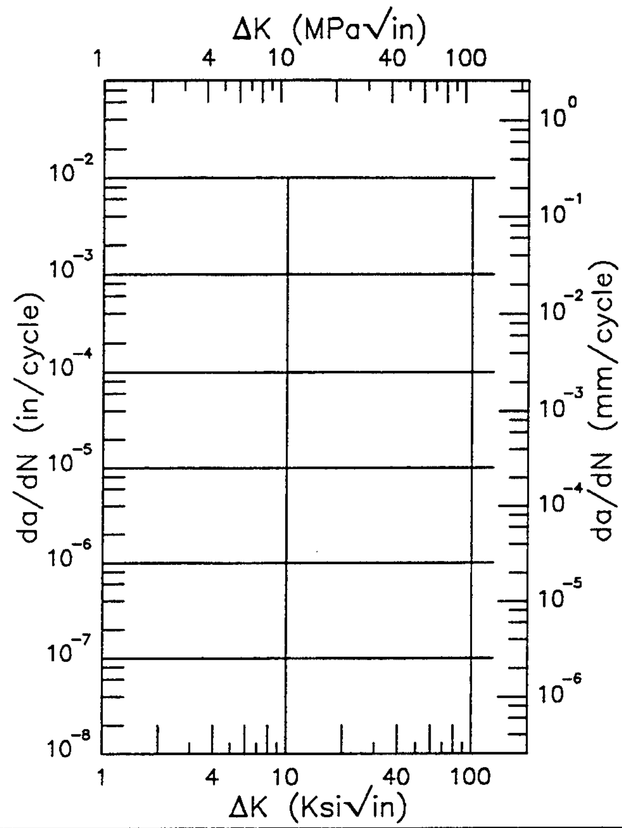
Figure 4.7.3.1.9

Condition/Ht: ANNEALED & AGED
Form: 0.5 in. Plate
Specimen Type: CT
Orientation:
Frequency: 3 Hz
Environment: LAB AIR; RT

Yield Strength: 39.6 ksi
Ult. Strength: 77.1 ksi
Specimen Thk: 0.496 in.
Specimen Width: 2.001 in.
Ref: HD008

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.08 (min)	1.13
20.	1.39
25.	3.93
30.	11.4
35.	27.5
35.83 (max)	30.0

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
2.45

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

Figure 4.7.3.1.10

TABLE 4.8.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
316 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle) ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
ANNEALED	PLATE	0.05	10				2.49		

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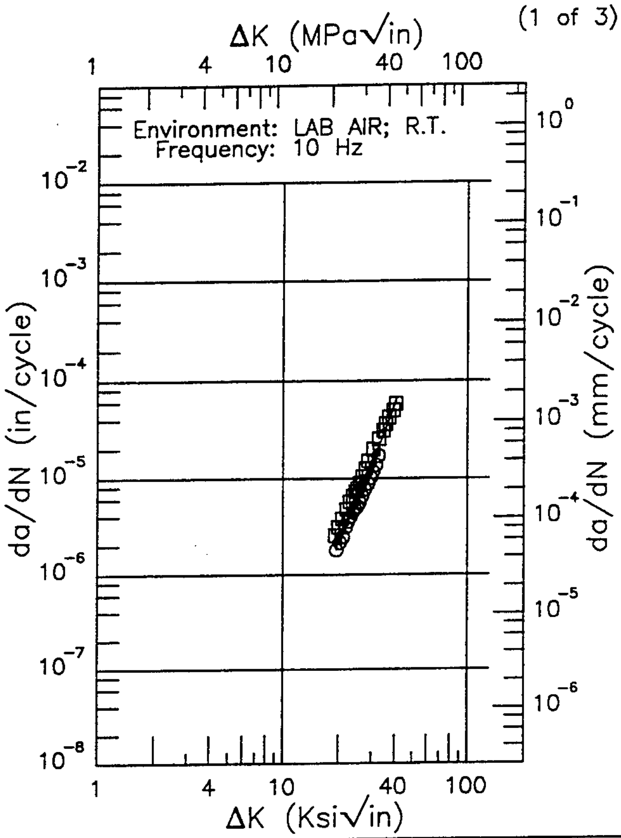
EF **316**

Condition/Ht: ANNEALED
Form: 0.5 in. Plate
Specimen Type: CT
Orientation:
Stress Ratio: 0.05

Yield Strength: 44.1 ksi
Ult. Strength: 82.1 ksi
Specimen Thk: 0.486 – 0.504 in.
Specimen Width: 1.998 – 2.047 in.
Ref: HD013;HD012

(1 of 3)



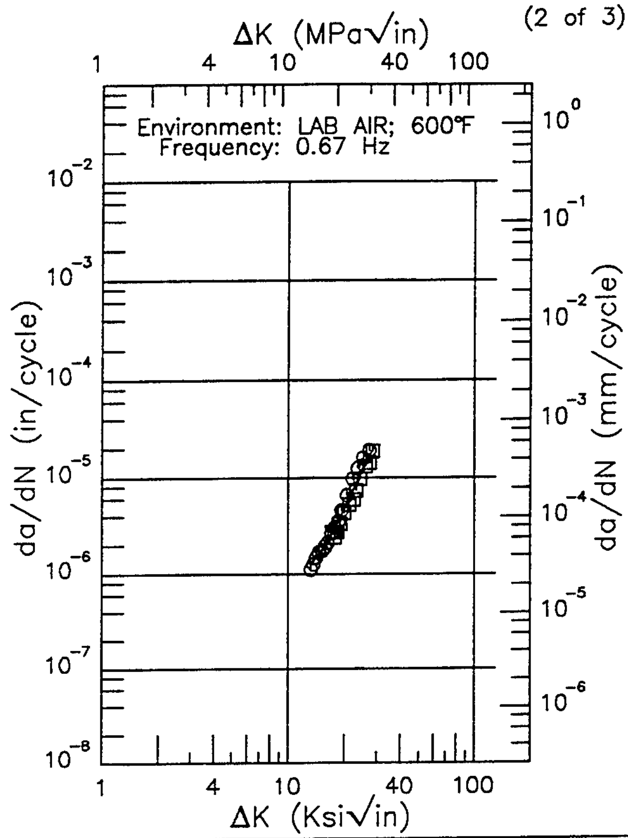
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
19.09 (min)	2.08
20.	2.49
25.	6.15
30.	13.8
35.	29.1
40.	58.5
40.55 (max)	63.0

RMS % Error: 21.55

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.24 (min)	1.24
16.	1.98
20.	4.72
25.	12.2
28.41 (max)	19.4

RMS % Error: 15.01

Life Prediction Ratio Summary

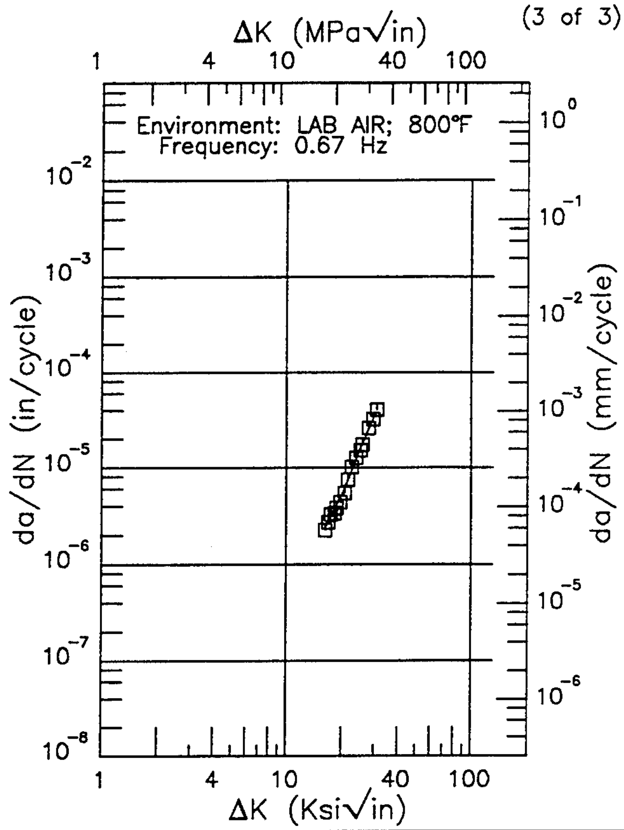
0. .5 .8 1.25 2.

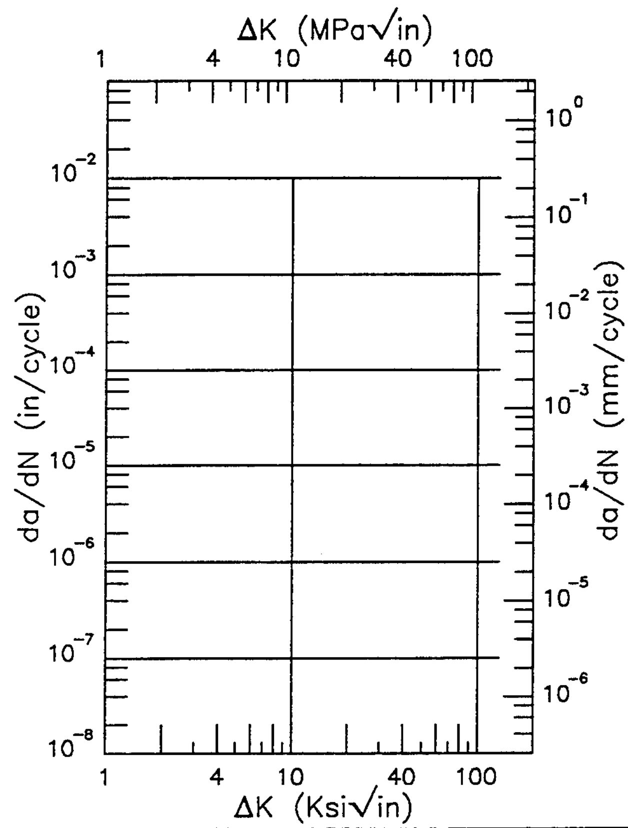
Figure 4.8.3.1.1

Condition/Ht: ANNEALED
Form: 0.5 in. Plate
Specimen Type: CT
Orientation:
Stress Ratio: 0.05

Yield Strength: 44.1 ksi
Ult. Strength: 82.1 ksi
Specimen Thk: 0.486 – 0.504 in.
Specimen Width: 1.998 – 2.047 in.
Ref: HD013;HD012

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
16.21 (min)	2.43
20.	5.14
25.	15.7
30.	35.2
30.70 (max)	38.1

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
5.85	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.8.3.1.1 (Concluded)

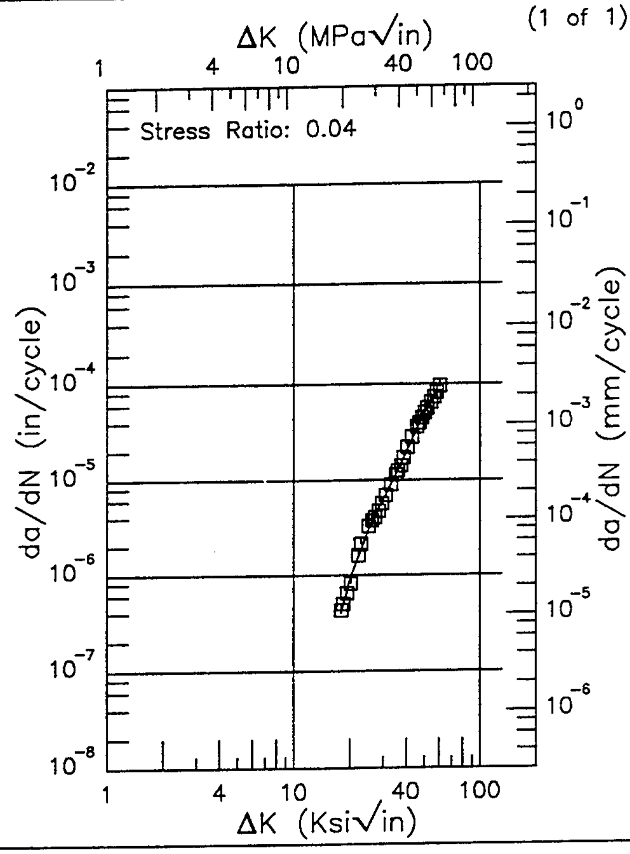
316

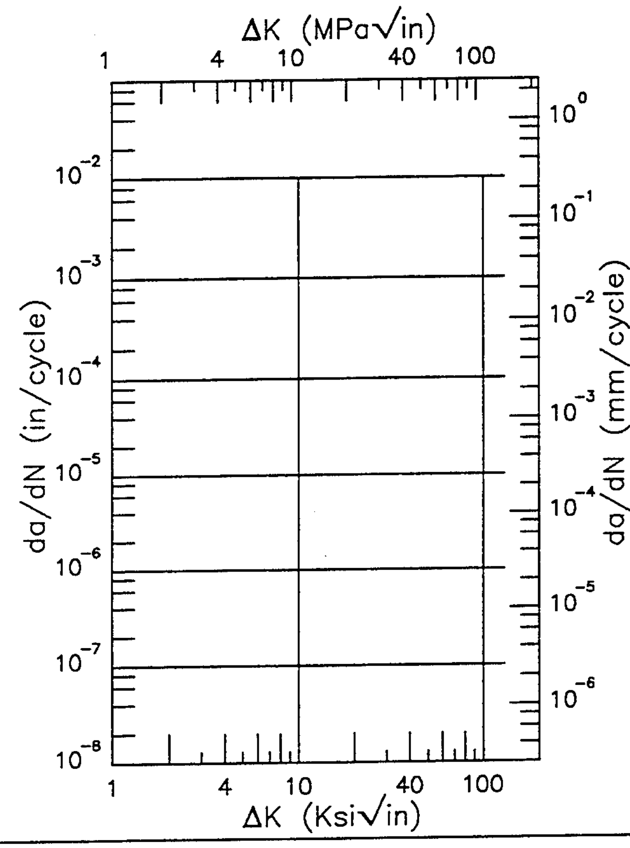
R

Condition/Ht: ANNEALED
Form: 0.5 in. Plate
Specimen Type: SENT
Orientation:
Frequency: 0.9 Hz
Environment: LAB AIR;98°F

Yield Strength: 44.1 ksi
Ult. Strength: 82.1 ksi
Specimen Thk: 0.504 in.
Specimen Width: 4.501 in.
Ref: HD013

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
17.85 (min)	0.397
20.	0.879
25.	2.91
30.	6.22
35.	11.3
40.	19.6
50.	51.1
60.	85.3
60.48 (max)	86.2

ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
6.02	0. .5 .8 1.25 2.

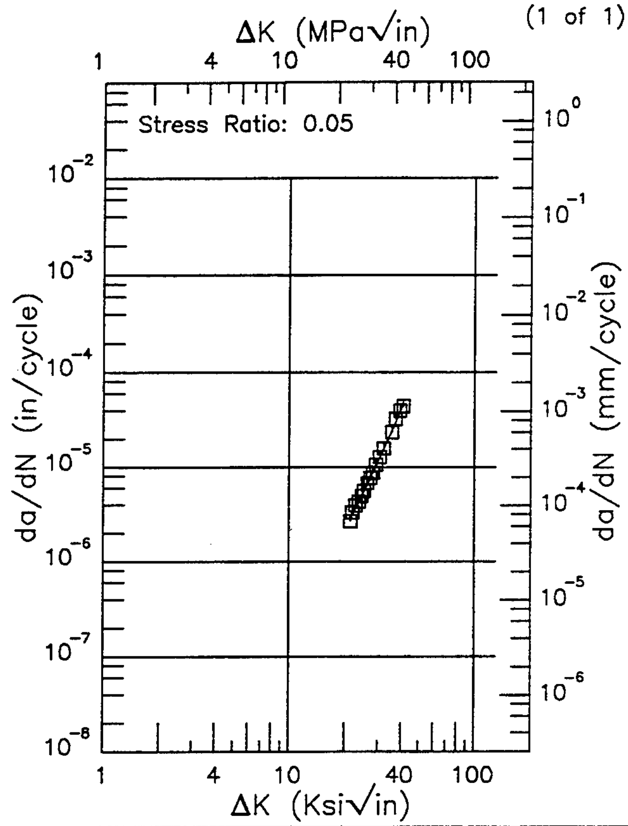
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

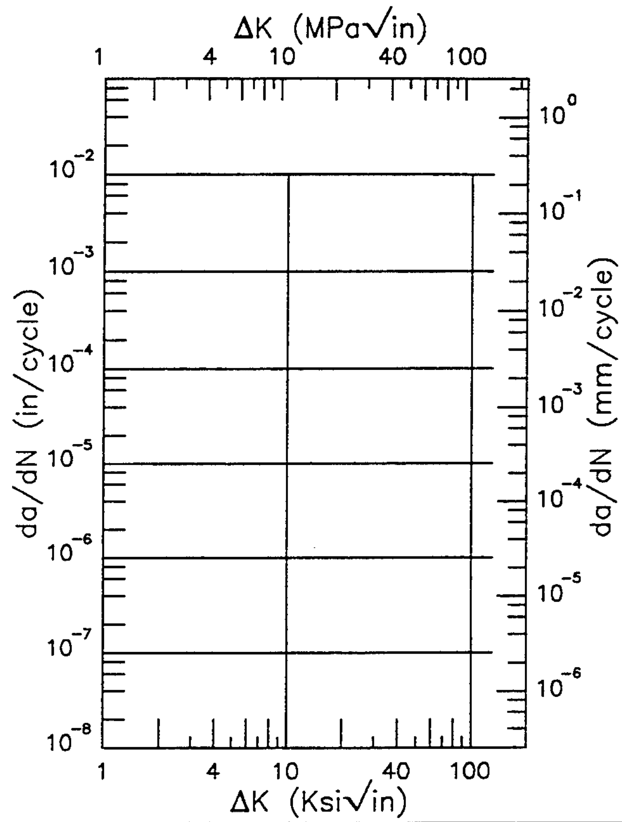
Figure 4.8.3.1.2

Condition/Ht: ANNEALED AT 1950F 1HR WQ
Form: 0.5 in. Plate
Specimen Type: CT
Orientation:
Frequency: 5 Hz
Environment: LAB AIR; RT

Yield Strength: 43 ksi
Ult. Strength: 81.5 ksi
Specimen Thk: 0.525 in.
Specimen Width: 2.001 in.
Ref: HD014

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
21.20 (min)	2.84
25.	5.45
30.	11.6
35.	22.8
40.	42.4
40.78 (max)	46.5

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
3.25

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.8.3.1.3

TABLE 4.9.1.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK 347 AT ROOM TEMPERATURE

ORIENTATION: Unspecified **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
.050 IN. FROM CENTERLINE	WELDMENT	0.1	30					10.26	
AT CENTERLINE	WELDMENT	0.1	30					13.37	
AT HEAT AFFECTED ZONE	WELDMENT	0.1	30					16.47	

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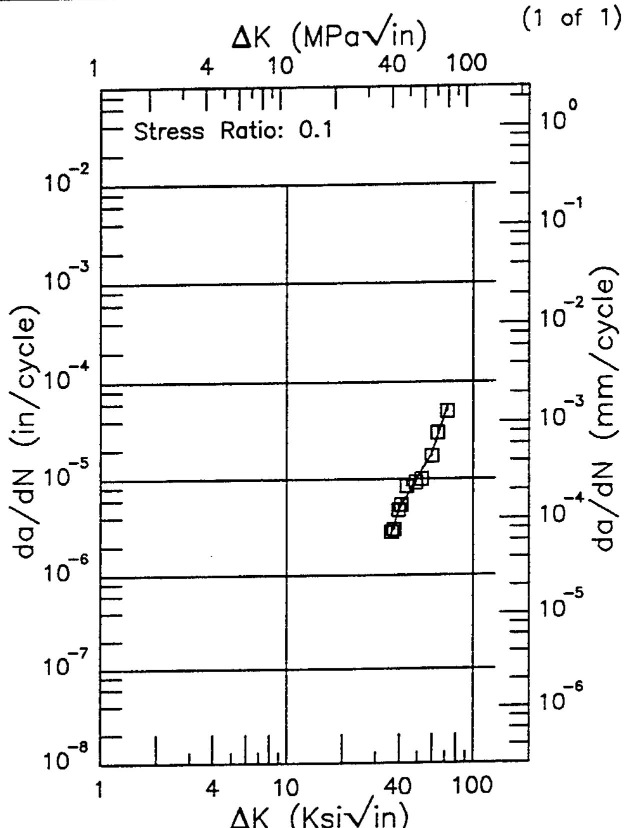
347

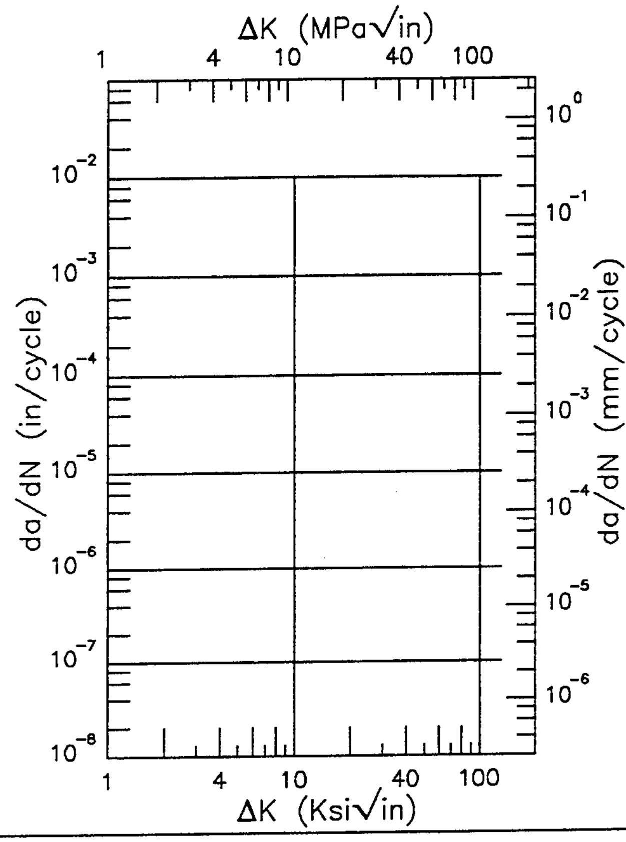
R

Condition/Ht: .050 IN. FROM CENTERLINE
Form: Weldment
Specimen Type: CT
Orientation:
Frequency: 30 Hz
Environment: LAB AIR; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 1 in.
Specimen Width: 5 in.
Ref: AM001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
36.21 (min)	2.70
40.	4.89
50.	10.3
60.	18.3
70.	46.1
71.59 (max)	55.7

ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

RMS % Error 12.37

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

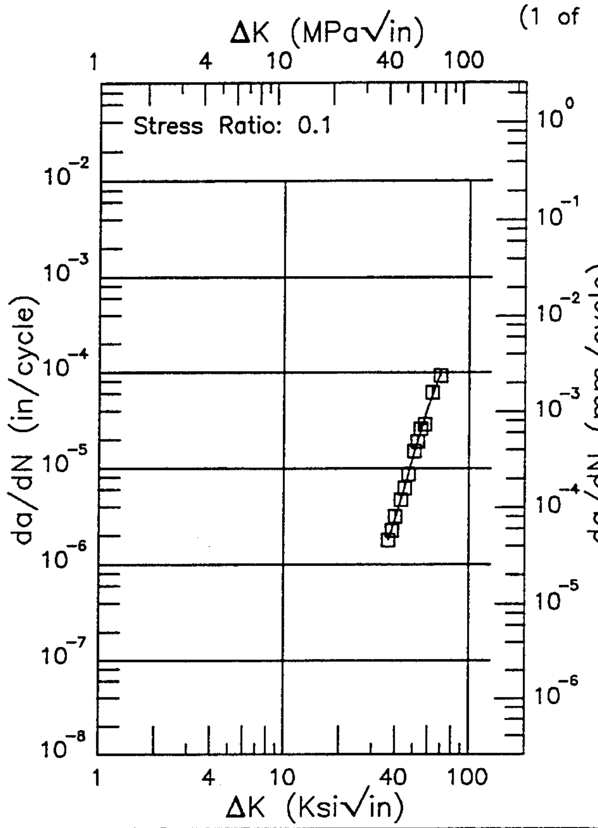
0. .5 .8 1.25 2.

Figure 4.9.3.1.1

Condition/Ht: AT CENTERLINE
Form: Weldment
Specimen Type: CT
Orientation:
Frequency: 30 Hz
Environment: LAB AIR; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 1 in.
Specimen Width: 5 in.
Ref: AM001

(1 of 1)

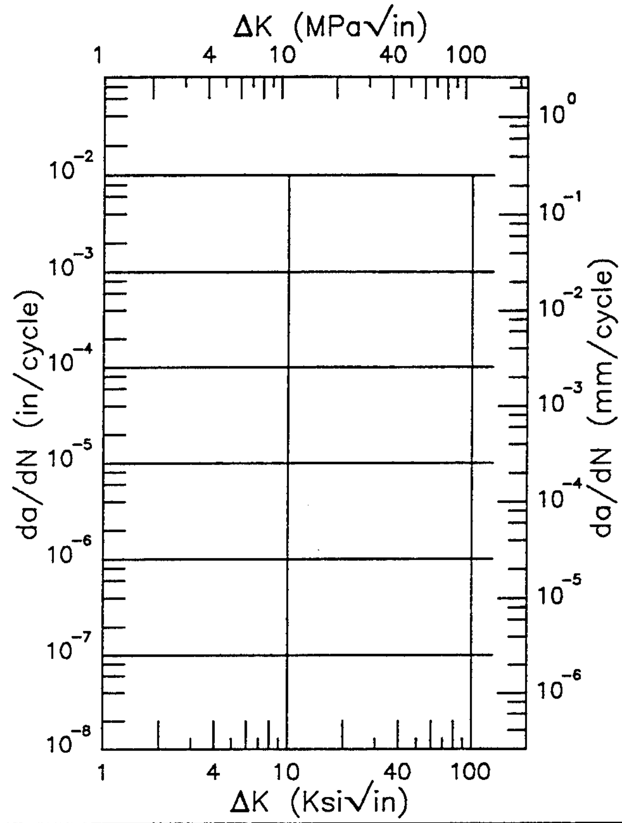


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
36.67 (min)	1.77
40.	3.00
50.	13.4
60.	43.4
69.67 (max)	95.0

RMS % Error
5.61

Life Prediction Ratio Summary

0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.9.3.1.2

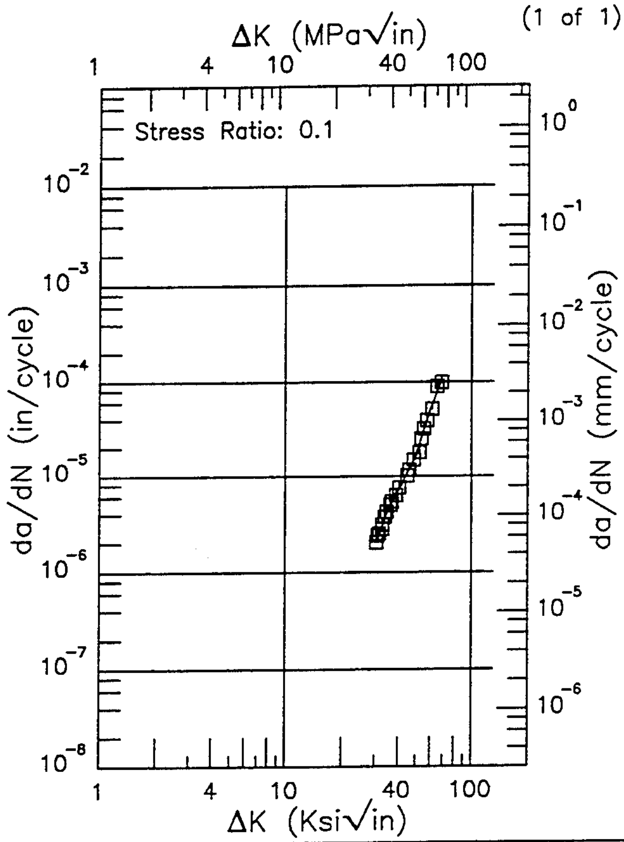
347

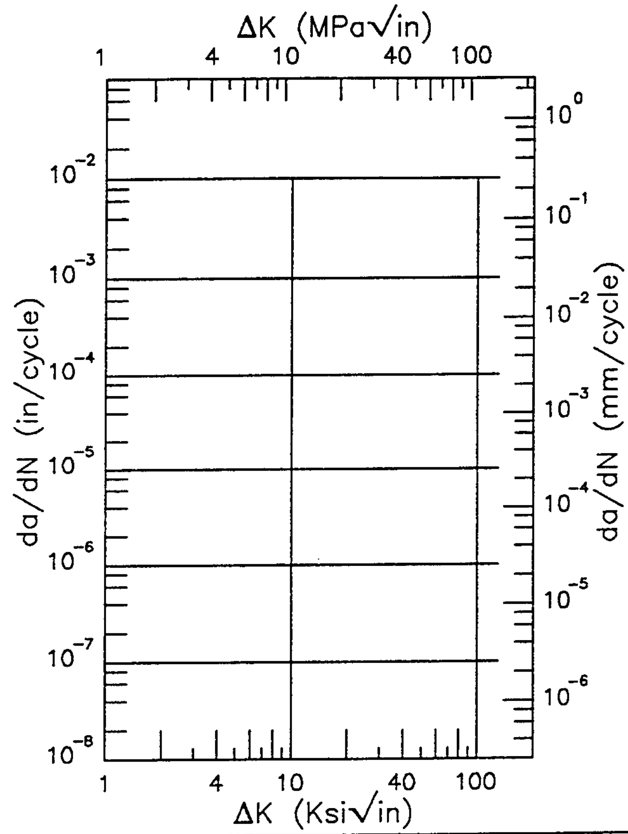
R

Condition/Ht: AT HEAT AFFECTED ZONE
Form: Weldment
Specimen Type: CT
Orientation:
Frequency: 30 Hz
Environment: LAB AIR; RT

Yield Strength:
Ult. Strength:
Specimen Thk: 1 in.
Specimen Width: 5 in.
Ref: AM001

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
30.61 (min)	2.01
35.	4.29
40.	6.99
50.	16.5
60.	50.6
68.77 (max)	105.

ΔK (Ksi√in) da/dN (10^{-6} in/cycle)

RMS % Error 6.53

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.9.3.1.3

TABLE 4.10.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL AFC 260

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
2200°F 1hr; 1900°F 1hr OQ; -100°F 1hr; -320°F 1hr; 800°F 2+2 hr	P	R.T.	T-L	---	3.5% NaCl	CANT*	1.5	0.48	0.56	---	64	59⁺	---	1971	80685
2200°F 1hr; 1900°F 1hr OQ; -100°F 1hr; -320°F 1hr; 900°F 2+2 hr	P	R.T.	T-L	196	3.5% NaCl	CANT*	1.5	0.48	0.56	---	47	40	---	1971	80685
2200°F 1hr; 1900°F 1hr OQ; -100°F 1hr; -320°F 1hr; 1000°F 2+2hr	P	R.T.	T-L	206	3.5% NaCl	CANT*	1.5	0.48	0.56	---	---	45	---	1971	80685
2200°F 1hr; 1900°F 1hr OQ; -100°F 1hr; -320°F 1hr; 1050°F 2+2hr	P	R.T.	T-L	185	3.5% NaCl	CANT*	1.5	0.48	0.56	---	---	37	---	1971	80685

⁺ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 4.11.2.1

STAINLESS STEEL AFC 77 K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi • $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
1800F 1HR OQ -100F 0.5HR 1000F 2+2HR (FINE GRAIN)	Plate	0.56	R.T.	L-T	232.0	1.500	0.500	NB	---	0.04	30.00	---	---	1969	74720 (1)
1800F 1HR OQ -100F 0.5HR 700F 2+2HR (FINE GRAIN)	Plate	0.56	R.T.	L-T	203.0	1.500	0.500	NB	---	0.15	49.00	---	---	1969	74720 (1)
1800F 1HR OQ -100F 0.5HR 800F 2+2HR (FINE GRAIN)	Plate	0.56	R.T.	L-T	224.0	1.500	0.500	NB	---	0.05	31.00	---	---	1969	74720 (1)
1800F 1HR OQ -100F 1HR 700F 2+2HR	Round Bar	3.00	R.T.	L-R	185.0	1.500	0.480	NB	---	0.14	44.00	---	---	1968	84302 (1)
1800F 1HR OQ -100F 1HR 800F 2+2HR	Round Bar	3.00	R.T.	L-R	213.0	1.500	0.480	NB	---	0.05	29.00	---	---	1968	84302 (1)
1800F 1HROQ -100F 0.5HR 1000F 2+2HR (COARSE GRAIN)	Plate	0.56	R.T.	L-T	173.0	1.500	0.500	NB	---	0.05	25.00	---	---	1969	74720 (1)
1800F 1HROQ -100F 0.5HR 700F 2+2HR (COARSE GRAIN)	Plate	0.56	R.T.	L-T	183.0	1.500	0.500	NB	---	0.11	38.00	---	---	1969	74720 (1)
1800F 1HROQ -100F 0.5HR 800F 2+2HR (COARSE GRAIN)	Plate	0.56	R.T.	L-T	208.0	1.500	0.500	NB	---	0.05	28.00	---	---	1969	74720 (1)
1900F 1HR OQ -100F 1HR 800F 2+2HR	Round Bar	3.00	R.T.	L-R	222.0	1.500	0.480	NB	---	0.28	74.00	---	---	1968	84302 (1)
2000F 1HR OQ -100F 1HR 800F 2+2HR	Round Bar	3.00	R.T.	L-R	207.0	1.500	0.480	NB	---	0.29	70.00	---	---	1969	76136 (1)
2000F 1HR OQ -100F 1HR 900F 2+2HR	Round Bar	3.00	-65	L-R	---	1.500	0.480	NB	---	---	32.00	---	---	1968	84302 (1)
2000F 1HR OQ -100F 1HR 900F 2+2HR	Round Bar	3.00	R.T.	L-R	214.0	1.500	0.480	NB	---	0.17	56.00	---	---	1969	76136 (1)

NOTES: (1) COMPOSITION (WT PERCENT) 0.16C, 0.18Mn, 0.015P, 0.021S, 0.13Si, 0.21Ni, 14.0Cr, 5.02Mo, 13.4Co, 0.23V, 0.04N
THESE DATA ARE AVERAGE VALUES

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AFC 77

Condition/Ht: AUSTENITIZED AT 2010F QUENCHED & TEMPERED AT 810F

Form: 0.08 in. Sheet

Specimen Type:

Orientation:

Yield Strength:

Ult. Strength:

Specimen Thk:

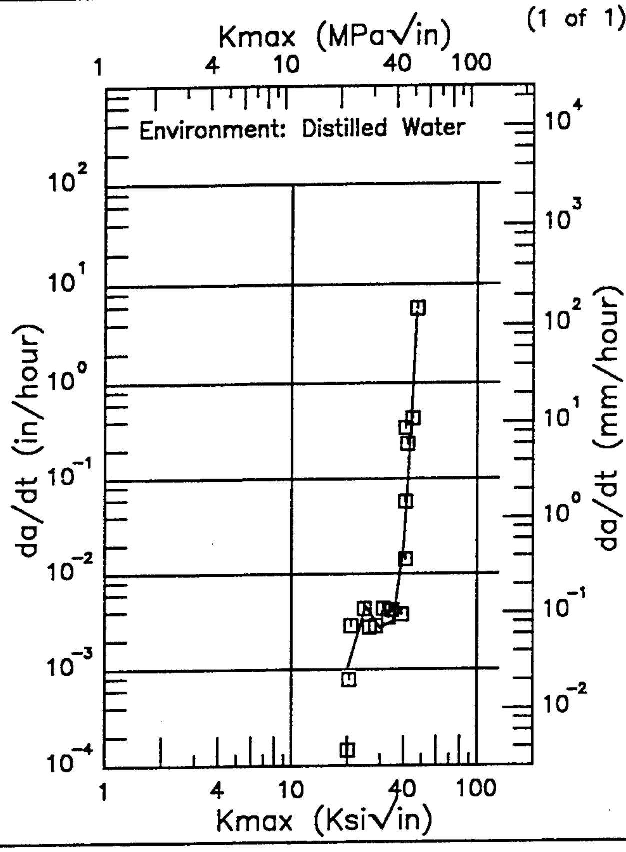
Specimen Width:

A_o:

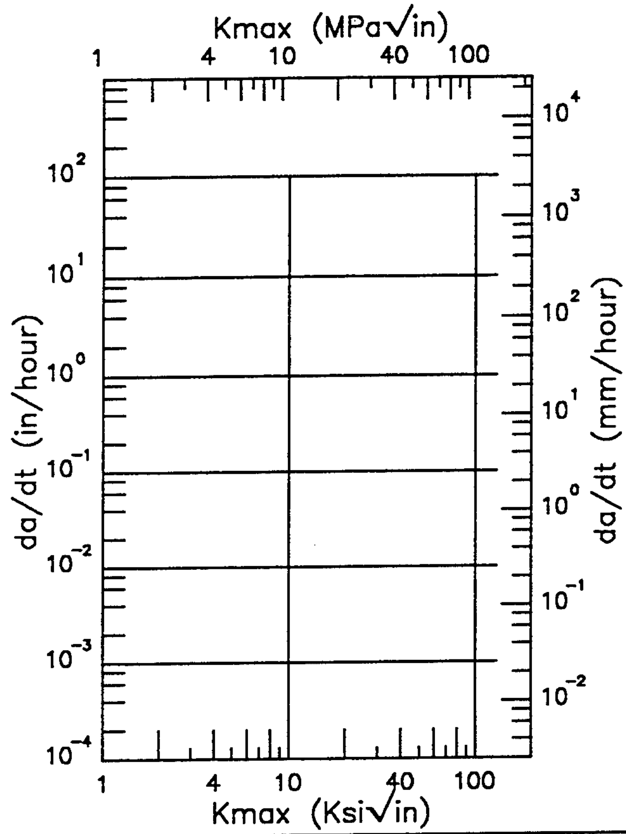
K_{Iscc}:

Ref: 85544

(1 of 1)



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)
20.00 (min)	1.01
25.	4.55
30.	2.67
35.	3.21
40.	19.5
47.00 (max)	5213.



Kmax (Ksi√in)	da/dt (10^{-3}in/hour)

RMS % Error	
>100.0	

RMS % Error	

Figure 4.11.3.2

TABLE 4.11.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL AFC 77

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
1800°F 1hr OQ; -100°F 0.5Hr;500°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	154	3.5% NaCl	CANT*	1.5	0.48	0.56	---	119	82+	---	1969	74720
1800°F 1hr OQ; -100°F 0.5Hr; 500°F 2+2 hr (Fine Grained Structure)	P	R.T.	---	196	3.5% NaCl	CANT*	1.5	0.48	0.56	---	111	97+	---	1969	74720
1800°F 1hr OQ; 100°F 0.5Hr; 1000°F 2+2 hr (Coarse Grained Structure)	P	R.T.	---	173	3.5% NaCl	CANT*	1.5	0.48	0.56	---	25	15	---	1969	74720
1800°F 1hr OQ; -100°F 0.5Hr; 1000°F 2+2hr (Fine Grained Structure)	P	R.T.	---	232	3.5% NaCl	CANT*	1.5	0.48	0.56	---	30	>20	---	1969	74720
2000°F 1hr OQ; -100°F 0.5Hr; 500°F 2+2hr	B	R.T.	---	169	3.5% NaCl	CANT*	1.5	0.48	3	---	200	105+	---	1969	76136
2000°F 1hr OQ; -100°F 0.5Hr; 500°F 2+2hr + 10% CW	B	R.T.	---	252	3.5% NaCl	CANT*	1.5	0.48	3	---	80	30	---	1969	76136
				277	3.5% NaCl	CANT*	1.5	0.48	3	---	106	90	---	1969	76136
2000°F 1hr OQ; -100°F 0.5Hr; 500°F 2+2hr + 20% CW	B	R.T.	---	297	3.5% NaCl	CANT*	1.5	0.48	3	---	107	48	---	1969	76136

TABLE 4.11.3.3 (CONCLUDED)

K_{Iscc} SUMMARY FOR STAINLESS STEEL AFC 77

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
2000°F 1hr OQ; -100°F 0.5Hr; 700°F 2+2 hr	B	R.T.	---	180	3.5% NaCl	CANT*	1.5	0.48	3	---	160	50	---	1969	76136
2000°F 1hr OQ; -100°F 0.5hr; 800°F 2+2 hr	B	R.T.	---	207	3.5% NaCl	CANT*	1.5	0.48	3	---	70	40	---	1969	76136
2000°F 1hr OQ; -100°F 0.5hr; 900°F 2+2 hr	B	R.T.	---	214	3.5% NaCl	CANT*	1.5	0.48	3	---	56	35	---	1969	76136
2000°F 1hr OQ; -100°F 0.5hr; 1100°F 2+2 hr	B	R.T.	---	221	3.5% NaCl	CANT*	1.5	0.48	3	---	43	10	---	1969	76136
2000°F 1hr OQ; -100°F 0.5hr; 1400°F 2+2 hr	B	R.T.	---	150	3.5% NaCl	CANT*	1.5	0.48	3	---	116	80+	---	1969	76136
2100°F 1hr FC to 1900°F hold 1hr OQ -100°F 4hr 500°F 2+2 hr	F	R.T.	L-T	165.8	3.5% NaCl	NB*	20	0.5	10	0.4	108	>10	---	1973	87360
			T-L	164.6	3.5% NaCl	NB*	15	0.5	10	0.4	110	>10	---	1973	87360

+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 4.12.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR STAINLESS STEEL ALLOY AFC 77 (VAR) AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1700F 1HR OQ 2100F 1HR MOVE TO FCE AT 1933F HELD 1HR OQ -100F 24HR 900	48.6	3.1	7	50.8	1.3	7	---	---	---
	2100F 1HR MOVED TO FCE AT 1900F HELD 1HR OQ -100F 4HR 500F 2+2HR	110.5	4.9	2	108	5.7	2	---	---	---

TABLE 4.12.2.1

STAINLESS STEEL AFC 77 (VAR) K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	$2.5*(K_Q/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_Q (Ksi√in.)	K_Q MEAN	STAN DEV		
1700F 1HR OQ 2100F 1HR MOVED TO FCE AT 1933F HELD 1HR OQ -100F 24HR 900F 2+2HR	Forging	6.00	-65	L-T	210.0	1.002	0.501	NB	0.513	0.10	42.40	41.9	0.8	1973	87360 (1)
		6.00			210.0	1.002	0.501	NB	0.510	0.10	41.30			1973	87360 (1)
1700F 1HR OQ 2100F 1HR MOVED TO FCE AT 1933F HELD 1HR OQ -100F 24HR 900F 2+2HR	Forging	6.00	-65	T-L	210.0	1.002	0.501	NB	0.523	0.11	43.30	47.9	6.4	1973	87360 (1)
		6.00			210.0	1.002	0.501	NB	0.520	0.16	52.40			1973	87360 (1)
1700F 1HR OQ 2100F 1HR MOVED TO FCE AT 1933F HELD 1HR OQ -100F 24HR 900F 2+2HR	Forging	6.00	R.T.	L-T	192.0	1.002	0.500	NB	0.520	0.16	47.90	48.6	3.1	1973	87360 (1)
		6.00			192.0	1.002	0.500	NB	0.507	0.13	44.40			1973	87360 (1)
		6.00			192.0	1.002	0.501	NB	0.527	0.14	45.60			1973	87360 (1)
		6.00			192.0	1.002	0.501	NB	0.523	0.19	53.40			1973	87360 (1)
		6.00			192.0	1.002	0.501	NB	0.505	0.18	50.80			1973	87360 (1)
		6.00			192.0	1.002	0.500	NB	0.533	0.16	48.80			1973	87360 (1)
		6.00			192.0	1.002	0.501	NB	0.510	0.17	49.60			1973	87360 (1)
1700F 1HR OQ 2100F 1HR MOVED TO FCE AT 1933F HELD 1HR OQ -100F 24HR 900F 2+2HR	Forging	6.00	R.T.	T-L	194.0	1.002	0.501	NB	0.525	0.17	49.90	50.8	1.3	1973	87360 (1)
		6.00			194.0	1.002	0.501	NB	0.520	0.18	52.60			1973	87360 (1)
		6.00			194.0	1.002	0.501	NB	0.513	0.16	48.80			1973	87360 (1)
		6.00			194.0	1.002	0.501	NB	0.513	0.18	52.00			1973	87360 (1)
		6.00			194.0	1.002	0.501	NB	0.510	0.17	50.70			1973	87360 (1)
		6.00			194.0	1.002	0.501	NB	0.515	0.17	50.40			1973	87360 (1)
		6.00			194.0	1.002	0.501	NB	0.500	0.17	51.00			1973	87360 (1)

NOTES: (1) COMPOSITION (WT PERCENT) 0.15C, 0.08Mn, 0.012P, 0.004S, 0.20Si, 1.17Ni, 13.7Cr, 5.02Mo, 13.5Co, 0.30V, 0.18Cb, 0.020N

TABLE 4.12.2.1 (CONCLUDED)

STAINLESS STEEL AFC 77 (VAR) K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi√in.)	K_{Ic} MEAN	STAN DEV		
2100F 1HR MOVED TO FCE AT 1900F HELD 1HR OQ -100F 4HR 500F 2+2HR	Forging	6.00	-65	L-T	180.0	0.995	0.495	NB	0.477	0.46	77.70	---	---	1973	87360
2100F 1HR MOVED TO FCE AT 1900F HELD 1HR OQ -100F 4HR 500F 2+2HR	Forging	6.00	-65	T-L	180.0	0.995	0.497	NB	0.490	0.35	67.10	70.5	4.8	1973	87360
		6.00			180.0	0.994	0.497	NB	0.533	0.42	73.90			1973	87360
2100F 1HR MOVED TO FCE AT 1900F HELD 1HR OQ -100F 4HR 500F 2+2HR	Forging	6.00	R.T.	L-T	165.0	4.000	2.007	CT	2.090	1.19	114.00	110.5	4.9	1973	87360
		6.00			165.0	4.000	2.006	CT	2.110	1.05	107.00			1973	87360
2100F 1HR MOVED TO FCE AT 1900F HELD 1HR OQ -100F 4HR 500F 2+2HR	Forging	6.00	R.T.	T-L	166.0	4.000	2.006	CT	2.070	0.98	104.00	108.0	5.7	1973	87360
		6.00			166.0	4.000	2.007	CT	2.110	1.14	112.00			1973	87360

TABLE 4.13.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL AM 355

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
						Design	Width (in)	Thick (in)							
MOD SCT1000	B	R.T.	---	163.2	3.5% NaCl	CANT	1.5	0.48	2.25	---	117	117+	30000	1971	84333
SCT 850	P	R.T.	T-L	152.5	20% NaCl	CT	2	1	1.13	---	48	8	---	1973	86688
					Industrial Atm	CT	2	1	1.13	---	48	45	---	1973	86688
					Seacoast Atm	CT	2	1	1.13	---	48	24	---	1973	86688
	B	R.T.	---	180	3.5% NaCl	CANT	1.5	0.48	2.25	---	59.2	32.5	30000	1971	84333
			T-L	190.3	20% NaCl	CT	2	1	2	---	36.6	6	---	1973	86688
					Industrial Atm	CT	2	1	2	---	36.6	18	---	1973	86688
					Seacoast Atm	CT	2	1	2	---	36.6	18	---	1973	86688
SCT1000	P	R.T.	T-L	169.7	20% NaCl	CT	2	1	1.13	---	104.7	37	---	1973	86688
					Industrial Atm	CT	2	1	1.13	---	104.7	99	---	1973	86688
					Seacoast Atm	CT	2	1	1.13	---	104.7	52	---	1973	86688
	B	R.T.	---	171.2	3.5% NaCl	CANT	1.5	0.48	2.25	---	88.4	88.4+	30000	1971	84333
			T-L	172.4	20% NaCl	CT	2	1	2	---	70	28	---	1973	86688
					Industrial Atm	CT	2	1	2	---	70	66	---	1973	86688
					Seacoast Atm	CT	2	1	2	---	70	35	---	1973	86688

+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 4.14.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL AM 362

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
H900	B	R.T.	---	200.5	3.5% NaCl	CANT	1.5	0.48	2.25	---	30.2	12.5	42000	1971	84333
H1000	B	R.T.	---	178.9	3.5% NaCl	CANT	1.5	0.48	2.25	---	40.1	31	36000	1971	84333

TABLE 4.15.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL AM 364

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
						Design	Width (in)	Thick (in)							
H850	F	R.T.	T-L	183.3	3.5% NaCl	CANT	1.5	0.48	3	---	131	93⁺	60000	1971	84333
H950	F	R.T.	T-L	186.7	3.5% NaCl	CANT	1.5	0.48	3	---	128	128⁺	60000	1971	84333

⁺ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

TABLE 4.16.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR STAINLESS STEEL ALLOY CUSTOM 455 AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Forging	1500F 1HR OQ 900F 4HR AC	46.2	3.3	3	---	---	---	---	---	---
	1500F 1HR OQ 950F 4HR AC	72.1	7.8	2	---	---	---	---	---	---

TABLE 4.16.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK CUSTOM 455 AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGING	0.1	10-30				2.76		
		0.3	20-30				3.72		

TABLE 4.16.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK CUSTOM 455 AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGING	0.1	10					25	
		0.1	20				3.11		
		0.1	20-30				2.52		

TABLE 4.16.2.1

STAINLESS STEEL CUSTOM 455 K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi√in.)	K_{Ic} MEAN	STAN DEV		
1500F 1HR OQ 900F 4HR AC	Forging	4.00	R.T.	L-T	255.0	1.500	0.480	NB	0.310	0.09	47.70	46.2	3.3	---	77934
		4.00			255.0	1.500	0.480	NB	0.330	0.09	48.40			---	77934
		4.00			255.0	1.500	0.480	NB	0.320	0.07	42.40			---	77934
1500F 1HR OQ 950F 4HR AC	Forging	4.00	R.T.	L-T	246.0	1.500	0.480	NB	0.310	0.25	77.60	72.1	7.8	---	77934
		4.00			246.0	1.500	0.480	NB	0.310	0.18	66.60			---	77934

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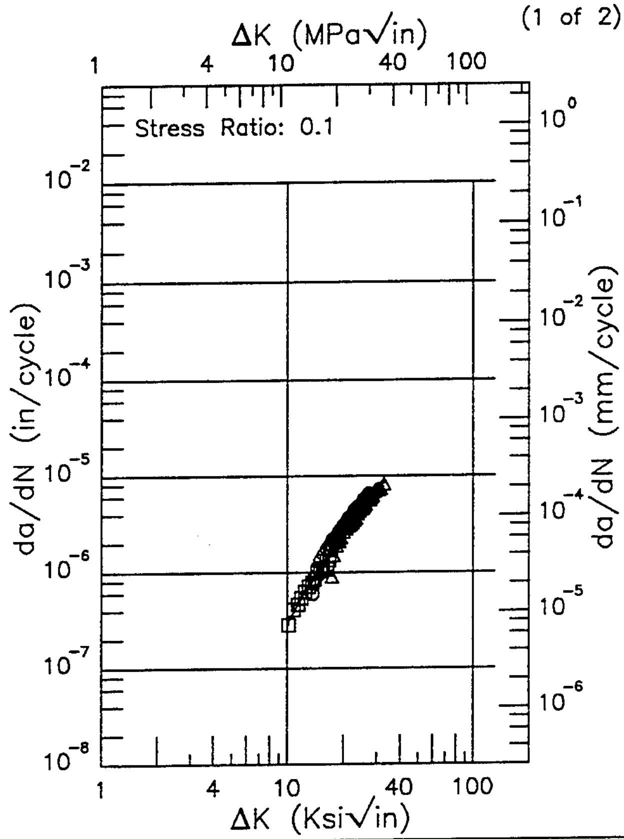
R

CUSTOM 455

Condition/Ht: H1000
Form: 2.5 in. Forging
Specimen Type: CT
Orientation: L–T
Frequency: 10 – 30 Hz
Environment: LAB AIR; RT

Yield Strength: 195 ksi
Ult. Strength: 204.4 ksi
Specimen Thk: 0.75 in.
Specimen Width: 2.1 in.
Ref: RI004

(1 of 2)



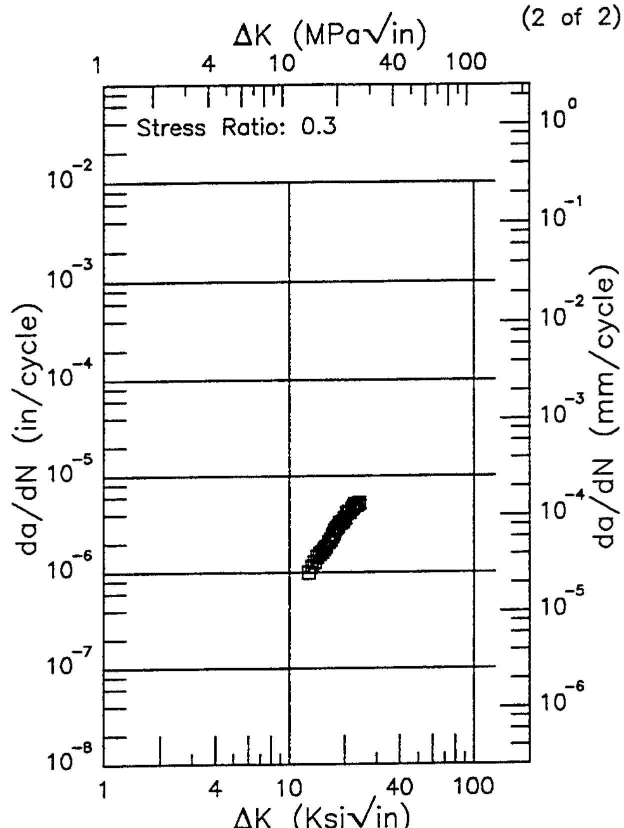
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.07 (min)	0.311
13.	0.708
16.	1.40
20.	2.76
25.	4.90
30.	6.98
32.83 (max)	7.91

RMS % Error 11.65

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.71 (min)	1.04
13.	1.10
16.	1.99
20.	3.72
23.86 (max)	5.31

RMS % Error 2.80

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.16.3.1.1

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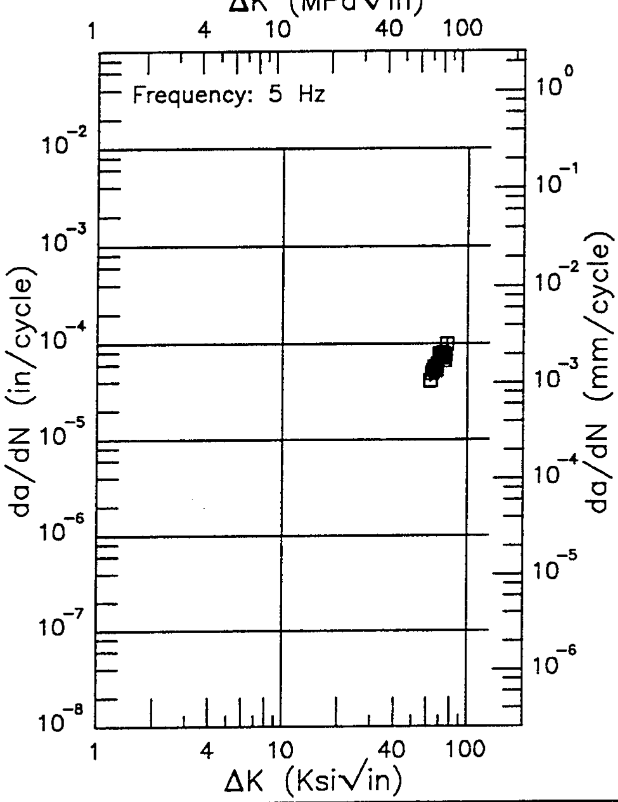
CUSTOM 455

F

Condition/Ht: H1000
Form: 2.5 in. Forging
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.1
Environment: LAB AIR; RT

Yield Strength: 195 ksi
Ult. Strength: 204.4 ksi
Specimen Thk: 0.75 in.
Specimen Width: 2.1 in.
Ref: RI004

(1 of 4)



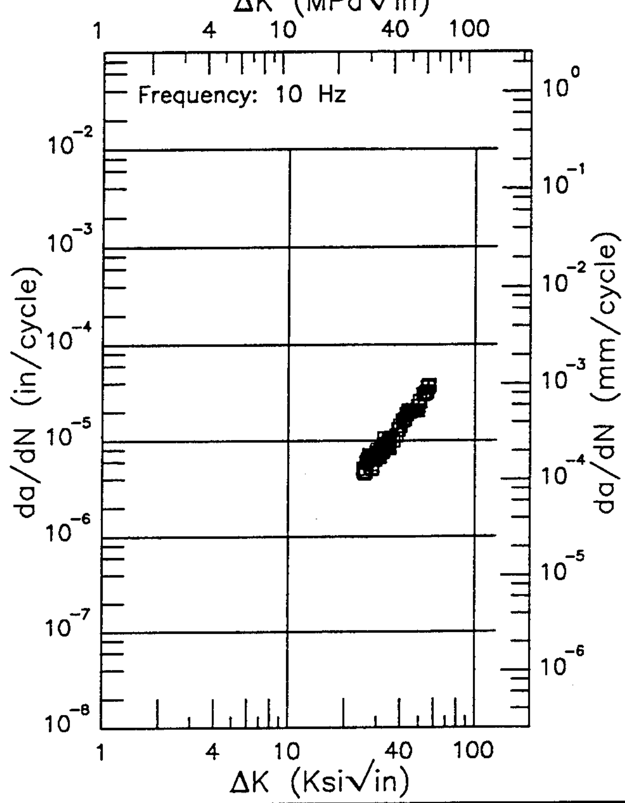
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
62.02 (min)	39.7
70.	68.9
76.71 (max)	82.1

RMS % Error: 10.17

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
25.12 (min)	4.98
30.	7.09
35.	10.0
40.	13.9
50.	25.0
56.40 (max)	35.0

RMS % Error: 9.32

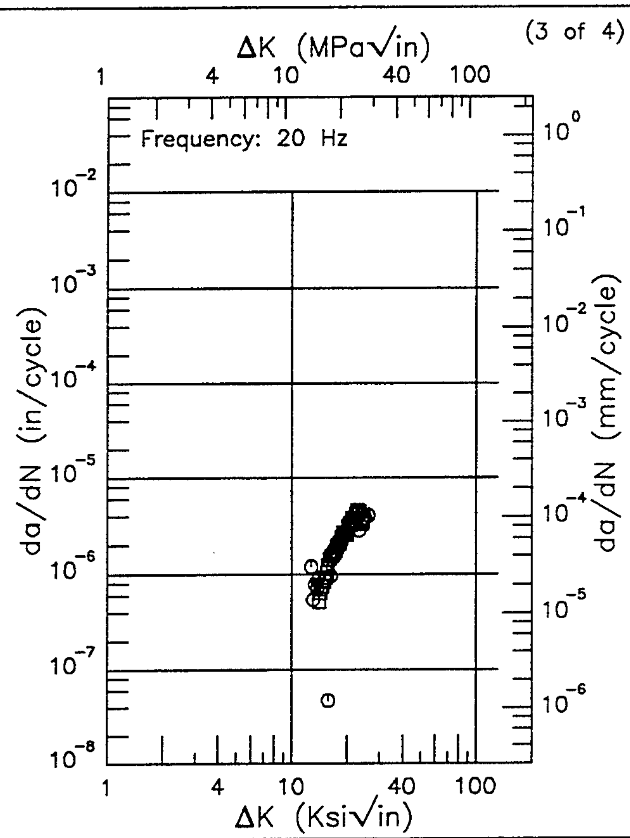
Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.16.3.1.2

Condition/Ht: H1000	Yield Strength: 195 ksi
Form: 2.5 in. Forging	Ult. Strength: 204.4 ksi
Specimen Type: CT	Specimen Thk: 0.75 in.
Orientation: T–L	Specimen Width: 2.1 in.
Stress Ratio: 0.1	Ref: RI004
Environment: LAB AIR; RT	

(3 of 4)

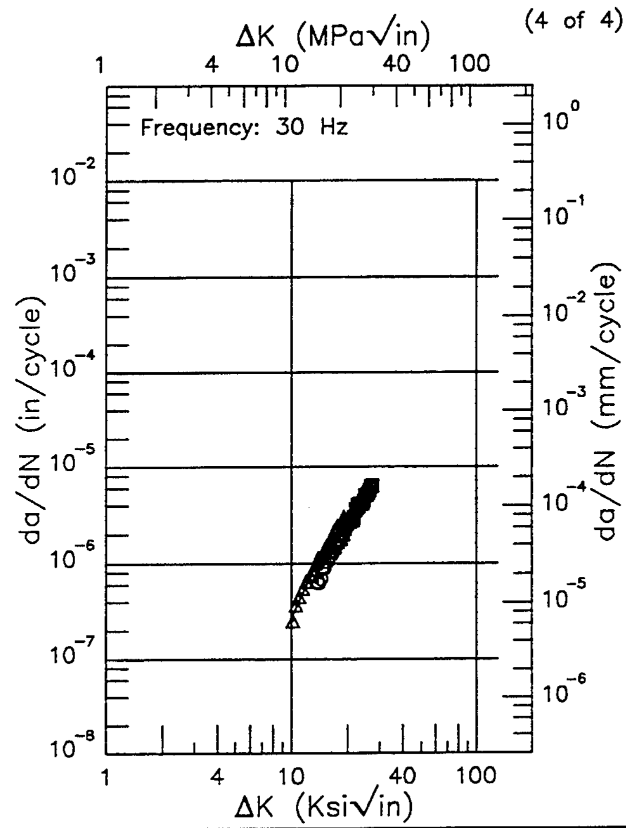


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.70 (min)	0.911
13.	0.772
16.	1.03
20.	3.11
25.	3.80
25.96 (max)	3.95

RMS % Error: 21.66

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(4 of 4)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.09 (min)	0.290
13.	0.825
16.	1.47
20.	2.52
25.	4.79
27.10 (max)	6.44

RMS % Error: 14.13

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 4.16.3.1.2 (Concluded)

TABLE 4.16.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL CUSTOM 455

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
H900	F	R.T.	---	255	3.5% NaCl	CANT	1.5	0.5	4	---	62	60	60000	1969	77934
H950	F	R.T.	---	246	3.5% NaCl	CANT	1.5	0.48	4	---	72.1	72.1	60000	1971	84333

TABLE 4.17.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR STAINLESS STEEL ALLOY PH13-8Mo AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Sheet	H950	58.4	6.5	2	69.4	16.1	4	---	---	---
	H1000	105.6	4.8	6	96.2	5.2	4	---	---	---
Plate	H1000	94.7	3.6	3	---	---	---	---	---	---
Forging	ANNEALED	114.1	15.7	5	99.6	22.4	6	---	---	---
	H950	70.3	16.	9	---	---	---	---	---	---
	H1000	101.6	11.	12	88.1	17.1	7	---	---	---
	H1050	143.3	9.2	3	122.	2.2	2	---	---	---
Extrusion	H1000	68.5	5.5	8	66.2	2.1	6	---	---	---
Forged Bar	AUSTENITE COND AND TRANSFORMED AT 38F AGED 1015F	103.	19.4	2	89.6	1.8	2	---	---	---
	H1000	114.2	0.9	2	122.7	3.	3	---	---	---
Rolled Bar	H950	66.9	2.9	3	63.5	1.7	6	74.1	2.1	3
	H1000	90	7.1	2	75	4.2	2	---	---	---
	H1050	103.1	4.6	3	94.9	7.8	6	92.2	4.2	2

TABLE 4.17.1.2.1

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1050	FORGING	0.1	1			0.41	11.67	159.49	
		0.8	1		0.08	1.38	14.47		

TABLE 4.17.1.2.2

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Dry Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	FCGR (10^{-6} in/cycle)					
				ΔK Level (Ksi√in)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGED BAR	0.08	6				5.82		
		0.08	6				5.82		
		0.1	6			0.24	3.08	29.91	
		0.1	6			0.24	3.08	29.91	
		0.3	6				4.63		
		0.3	6			0.58	4.17		
		0.3	6			0.43	4.46		
		0.5	6			0.71	4.93		
		0.5	6			0.49	4.36		
		0.5	6			0.63	4.52		
	BILLET	0.08	6			0.36	3.97		
	EXTRUDED BAR	0.08	6			0.38	3.86	34.13	
		0.08	6			0.38	3.86	34.13	
		0.5	6			0.84	5.58		
	ROLLED BAR	0.08	1-6			0.3	3.41		
		0.08	1-6			0.3	3.41		
		0.3	6			0.62	4.39		
		0.5	6			0.8	4.93		
Unspecified	EXTRUDED BAR	0.08	6				2.22	20.81	
		0.08	6				2.22	20.81	
		0.3	6				2.98		

TABLE 4.17.1.2.3

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK Level (Ksi√in) 2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGED BAR	0.1	1			0.36	8.11	102.77	
		0.1	1			0.36	8.11	102.77	
		0.3	1			0.82	11.3	129.3	
		0.3	1			0.8	10.77	123.85	
		0.5	1			0.93	13.34		
		0.5	1			0.91	12.96		

TABLE 4.17.1.2.4

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*) 2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGING	0.1	5-10				5.7	30.78	127.33
	BAR	0.02	10					31.58	
H1050	FORGING	-1	5			0.31	3.31	26.63	
		0.1	5			0.36	3.64	28.08	
		0.1	20				3.5	24.45	183.59
		0.4	5		0.06	0.56	4.82		
		0.4	20		0.05	0.53	4.28	31.06	
		0.4	5-20		0.06	0.53	4.55	32.68	
		0.8	15-30		0.1	0.89	5.33		

TABLE 4.17.1.2.5

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK
PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: L-T ENVIRONMENT: S.C.S.

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	ROLLED BAR	0.08	1				5.26	60.89	

TABLE 4.17.1.2.6

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* ($Ksi\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGING	0.1	1-10				9.07	65.46	

TABLE 4.17.1.2.7

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: L-T **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK Level (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	EXTRUDED BAR	0.08	1			0.64	7.11		
	ROLLED BAR	0.08	0.1				6.44		
		0.08	1				4.2		
		0.08	1				4.08		
		0.3	1			0.58	11.86		
Unspecified	EXTRUDED BAR	0.08	1				2.69		

TABLE 4.17.1.2.8

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Distilled Water**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1050	FORGING	0.1	1		0.06	0.8	19.74	136.09	
		0.1	1		0.06	0.8	19.74	136.09	
		0.8	1		0.08	1.26	13.82		

TABLE 4.17.1.2.9

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Dry Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				Δ*K Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGED BAR	0.1	6			0.24	3.12	24.51	
		0.1	6			0.24	3.12	24.51	
		0.3	6			0.45	4.07	36.4	
		0.3	6			0.45	4.05	36.63	
		0.5	6			0.51	4.56		
		0.5	6			0.51	4.56		
	BILLET	0.08	6			0.37	3.66	30.7	
	ROLLED BAR	0.08	6				4.05		
		0.08	6				4.05		

TABLE 4.17.1.2.10

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: H.H.A.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) *ΔK Level (Ksi√in)*					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGED BAR	0.1	1				6.49	109.06	
		0.1	1				6.49	109.06	
		0.3	1			0.63	9.62	215.14	
		0.3	1			0.63	9.62	215.14	
		0.5	1			1.15	11.52	578.58	
		0.5	1			1.08	12.45	568.44	

TABLE 4.17.1.2.11

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: Lab Air**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi√in*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGING	0.1	5-10				5.74	31.6	139.72
H1050	FORGING	0.1	7-20		0.04	0.31	3.07	25.59	
		0.1	20		0.03	0.27	2.99	23.2	
		0.4	20		0.05	0.53	4.3	27.43	
		0.4	5-20		0.06	0.54	4.43	29.07	
		0.8	15-30		0.1	0.91	5.42		

TABLE 4.17.1.2.12

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.S.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*)					
				ΔK *Level* (*Ksi*$\sqrt{in}$)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGING	0.1	1-10				8.51	67.86	385.3

TABLE 4.17.1.2.13

FATIGUE CRACK GROWTH RATE AT DEFINED LEVELS OF STRESS INTENSITY FACTOR ΔK PH13-8Mo AT ROOM TEMPERATURE

ORIENTATION: T-L **ENVIRONMENT: S.T.W.**

CONDITION/ HEAT TREATMENT	PRODUCT FORM	R	FREQ (Hz)	*FCGR* (10^{-6} *in/cycle*) ΔK *Level* (*Ksi$\sqrt{in}$*)					
				2.5	5.0	10.0	20.0	50.0	100.0
H1000	FORGED BAR	0.08	1				19.2		
	ROLLED BAR	0.08	1			0.3	7		

TABLE 4.17.2.1

STAINLESS STEEL PH13-8MO K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV		
ANNEALED	Forging	3.00	R.T.	L-T	200.7	4.000	2.003	CT	2.043	0.52	92.12	114.1	15.7	1976	NC001
		3.00			200.7	3.998	2.003	CT	2.073	0.66	103.80			1976	NC001
		3.00			200.7	3.997	1.996	CT	2.058	1.02	128.41			1976	NC001
		3.00			206.0	2.000	1.007	CT	1.026	0.94	126.90			1976	NC001
		3.00			206.0	4.000	1.999	CT	2.057	0.83	119.40			1976	NC001
ANNEALED	Forging	3.00	R.T.	T-L	202.0	3.999	1.996	CT	2.060	0.43	83.91	99.6	22.4	1976	NC001
		3.00			202.0	3.999	1.998	CT	2.061	0.73	109.27			1976	NC001
		3.00			202.0	4.000	2.003	CT	2.035	1.08	132.91			1976	NC001
		3.00			205.0	2.000	1.007	CT	1.025	0.76	113.50			1976	NC001
		3.00			207.0	3.938	2.002	CT	2.008	0.36	79.44			1976	NC001
		3.00			214.0	2.000	1.004	CT	1.005	0.33	78.36			1976	NC001
AUSTENITE COND AND TRANSFORMED AT 38F AGED 1015F	Forged Bar	2.20	R.T.	L-T	212.0	2.999	1.635	CT	1.577	0.76	116.70	103.0	19.4	1973	85836
		2.20			212.0	3.001	1.626	CT	1.597	0.44	89.20			1973	85836
AUSTENITE COND AND TRANSFORMED AT 38F AGED 1015F	Forged Bar	2.20	R.T.	T-L	212.0	3.001	1.628	CT	1.604	0.46	90.80	89.6	1.8	1973	85836
		2.20			212.0	3.001	1.634	CT	1.587	0.43	88.30			1973	85836
H 950	Sheet	1.50	R.T.	L-T	210.0	2.000	1.000	CT	1.000	0.22	63.00	58.4	6.5	1972	84365
		1.50			210.0	2.000	1.000	CT	1.000	0.16	53.80			1972	84365
H 950	Sheet	1.00	R.T.	T-L	210.0	---	---	NB	---	0.38	81.60	69.4	16.1	1972	84365
		2.25			210.0	---	---	NB	---	0.41	85.00			1972	84365
		1.50			210.0	2.000	1.000	CT	1.000	0.18	56.70			1972	84365
		1.50			210.0	2.000	1.000	CT	1.000	0.17	54.30			1972	84365

TABLE 4.17.2.1 (CONTINUED)

STAINLESS STEEL PH13-8MO K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	2.5 * $(K_Q/TYS)^2$ (in.)	K_{Ic} K_Q (Ksi * √in.)	K_{Ic} K_Q MEAN	K_{Ic} STAN DEV	DATE	REFER
H 950	Forging	4.00	R.T.	L-T	210.0	---	---	NB	---	0.39	83.60	70.3	16.0	1972	84365
		8.00			210.0	2.000	1.000	CT	1.000	0.13	47.00			1972	84365
		8.00			210.0	2.000	1.000	CT	1.000	0.19	57.80			1972	84365
		4.00			210.0	---	---	NB	---	0.18	55.90			1972	84365
		8.00			210.0	2.000	1.000	CT	1.000	0.19	58.20			1972	84365
		4.00			210.0	---	---	NB	---	0.40	84.50			1972	84365
		4.00			210.0	---	---	NB	---	0.40	83.90			1972	84365
		4.00			210.0	---	---	NB	---	0.28	70.50			1972	84365
		4.00			210.0	2.000	1.000	CT	1.000	0.47	91.30			1972	84365
H 950	Rolled Bar	2.25	R.T.	L-T	202.0	2.000	1.000	CT	1.069	0.30	70.00	66.9	2.9	1973	86688
		2.25			202.0	2.000	1.000	CT	1.040	0.27	66.40			1973	86688
		2.25			202.0	2.000	1.000	CT	1.077	0.25	64.20			1973	86688
H 950	Rolled Bar	2.25	R.T.	T-L	197.0	2.000	1.000	CT	1.060	0.24	60.90	63.5	1.7	1973	86688
		2.25			197.0	2.000	1.000	CT	1.030	0.26	64.00			1973	86688
		2.25			197.0	4.000	2.000	CT	2.028	0.28	66.20			1973	86688
		2.25			197.0	4.000	2.000	CT	2.071	0.26	63.60			1973	86688
		2.25			197.0	2.000	1.000	CT	1.049	0.25	62.80			1973	86688
		2.25			197.0	4.000	2.000	CT	1.996	0.26	63.40			1973	86688
H 950	Rolled Bar	2.25	R.T.	S-L	203.0	1.500	0.750	CT	0.797	0.32	72.20	74.1	2.1	1973	86688
		2.25			203.0	1.500	0.750	CT	0.780	0.33	73.80			1973	86688
		2.25			203.0	1.500	0.750	CT	0.738	0.35	76.40			1973	86688

TABLE 4.17.2.1 (CONTINUED)

STAINLESS STEEL PH13-8MO K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 * (K_Q/TYS)^2$ (in.)	K_Q (Ksi * √in.)	K_Q MEAN	STAN DEV	DATE	REFER
H1000	Sheet	1.50	R.T.	L-T	205.0	2.000	1.000	CT	1.000	0.58	98.50	105.6	4.8	1972	84365
		1.50			205.0	2.000	1.000	CT	1.000	0.71	109.00			1972	84365
		2.25			211.0	---	---	NB	---	0.59	103.00			1972	84365
		2.25			211.0	---	---	NB	---	0.68	110.00			1972	84365
		2.25			211.0	2.000	1.000	CT	1.000	0.60	103.00			1972	84365
		1.75			219.0	---	---	CT	---	0.63	110.00			1972	84365
H1000	Sheet	1.50	R.T.	T-L	205.0	2.000	1.000	CT	1.000	0.59	99.70	96.2	5.2	1972	84365
		1.50			205.0	2.000	1.000	CT	1.000	0.61	101.00			1972	84365
		2.25			213.0	2.000	1.000	CT	1.000	0.49	94.30			1972	84365
		2.25			214.0	2.000	1.000	CT	1.000	0.44	89.60			1972	84365
H1000	Plate	4.00	R.T.	L-T	201.0	3.501	0.978	CT	1.768	0.55	94.90	94.7	3.6	---	84306
		4.00			201.0	3.501	0.990	CT	1.761	0.59	98.10			---	84306
		4.00			201.0	3.501	0.994	CT	1.782	0.51	91.00			---	84306
H1000	Plate	4.00	R.T.	T-L	198.0	3.500	0.990	CT	1.796	0.54	93.40	---	---	---	84306
H1000	Forging	4.00	-65	L-T	185.0	3.994	1.381	CT	1.941	0.21	53.80	50.4	4.9	1973	85836
		5.00			195.0	2.000	1.000	CT	1.030	0.14	46.90			1973	85836
H1000	Forging	2.25	-65	T-L	215.0	3.000	1.630	CT	---	0.15	53.00	54.5	2.1	1974	90011
		4.00			215.0	3.000	1.630	CT	---	0.17	56.00			1974	90011
H1000	Forging	8.00	R.T.	L-T	205.0	2.493	1.261	CT	1.188	0.58	98.60	101.6	11.0	1974	88136
		8.00			205.0	1.000	2.000	CT	1.000	0.56	97.30			1973	85034
		8.00			205.0	2.495	1.258	CT	1.232	0.65	104.60			1974	88136
		4.00			205.0	1.000	2.000	NB	1.000	0.69	108.00			1972	84365
		8.00			205.0	2.497	1.259	CT	1.226	0.59	99.50			1974	88136

TABLE 4.17.2.1 (CONTINUED)

STAINLESS STEEL PH13-8MO K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi • √in.)	K_{Ic} MEAN	STAN DEV	DATE	REFER
H1000 Cont'd	Forging Cont'd	8.00	R.T. Cont'd	L-T Cont'd	205.0	1.000	2.000	CT	1.000	0.43	85.10	Cont'd	Cont'd	1973	85034
		4.00			205.0	1.000	2.000	NB	1.000	1.00	131.00			1972	84365
		6.00			209.0	1.998	0.753	CT	0.986	0.57	100.00			1973	85034
		6.00			210.0	1.997	0.751	CT	0.988	0.56	99.40			1973	85034
		4.00			211.0	1.000	2.000	CT	1.000	0.56	99.80			1973	85836
		4.00			212.0	1.000	2.000	CT	1.000	0.60	104.00			1973	85836
		4.00			212.0	1.000	2.000	CT	1.000	0.47	91.70			1973	85836
H1000	Forging	2.75	R.T.	T-L	196.0	2.003	0.751	CT	0.990	0.34	73.00	88.1	17.1	1973	85857
		2.75			196.0	2.002	0.752	CT	1.008	0.43	79.50			1973	85857
		2.75			196.0	2.003	0.750	CT	1.002	0.39	78.20			1973	85857
		2.75			196.0	2.004	0.750	CT	1.013	0.37	75.60			1973	85857
		6.00			199.0	2.001	0.752	CT	0.986	0.61	98.50			1973	85034
		6.00			201.0	1.999	0.752	CT	0.982	0.51	90.70			1973	85034
		8.00			205.0	1.000	2.000	CT	1.000	0.87	121.00			1973	85034
H1000	Forging	4.00	R.T.	S-T	202.0	3.002	1.368	CT	1.499	0.46	86.40	---	---	1973	85836
H1000	Extrusion	1.50	-65	L-T	215.0	3.000	1.000	CT	---	0.13	50.00	50.0	2.0	1974	90011
		1.50			215.0	3.000	1.000	CT	---	0.15	52.00			1974	90011
		1.50			215.0	3.000	1.000	CT	---	0.12	48.00			1974	90011
H1000	Extrusion	1.50	-65	T-L	215.0	3.000	1.000	CT	---	0.13	50.00	48.7	1.2	1974	90011
		1.50			215.0	3.000	1.000	CT	---	0.12	48.00			1974	90011
		1.50			215.0	3.000	1.000	CT	---	0.12	48.00			1974	90011

TABLE 4.17.2.1 (CONTINUED)

STAINLESS STEEL PH13-8MO K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5 \cdot (K_{Ic}/TYS)^2$ (in.)	K_{Ic}: K_{Ic} (Ksi • √in.)	K_{Ic}: K_{Ic} MEAN	K_{Ic}: STAN DEV	DATE	REFER
H1000	Extrusion	1.50	R.T.	L-T	208.0	3.000	1.000	CT	---	0.29	71.00	68.5	5.5	1974	90011
		1.50			208.0	3.999	1.417	CT	2.018	0.34	76.70			1973	85836
		1.50			208.0	3.000	1.000	CT	---	0.28	70.00			1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.25	66.00			1974	90011
		1.50			208.0	3.999	1.413	CT	1.973	0.30	72.20			1973	85836
		1.50			208.0	3.000	1.000	CT	---	0.21	61.00			1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.21	61.00			1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.28	70.00			1974	90011
H1000	Extrusion	1.50	R.T.	T-L	208.0	3.000	1.000	CT	---	0.22	62.00	66.2	2.1	1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.26	67.00			1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.26	67.00			1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.26	67.00			1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.25	66.00			1974	90011
		1.50			208.0	3.000	1.000	CT	---	0.27	68.00			1974	90011
H1000	Forged Bar	4.00	-65	L-T	210.0	2.006	0.998	CT	1.028	0.14	48.90	---	---	1973	85836
H1000	Forged Bar	1.00	R.T.	L-T	215.0	2.006	1.000	CT	1.052	0.69	113.50	114.2	0.9	1978	GD009
		1.00			215.0	2.004	1.000	CT	1.051	0.71	114.80			1978	GD009
H1000	Forged Bar	1.00	R.T.	T-L	216.0	2.005	1.001	CT	1.058	0.82	124.00	122.7	3.0	1978	GD009
		1.00			216.0	2.003	1.001	CT	1.034	0.83	124.80			1978	GD009
		1.00			216.0	2.004	1.005	CT	1.048	0.76	119.30			1978	GD009
H1000	Rolled Bar	1.50	R.T.	L-T	205.0	3.000	1.000	CT	---	0.43	85.00	90.0	7.1	1974	90011
		1.50			205.0	3.000	1.000	CT	---	0.54	95.00			1974	90011

TABLE 4.17.2.1 (CONTINUED)

STAINLESS STEEL PH13-8MO K_{Ic}

CONDITION	PRODUCT FORM	PRODUCT THICK (in.)	TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN WIDTH (in.) W	SPECIMEN THICK (in.) B	SPECIMEN DESIGN	CRACK LENGTH (in.) A	$2.5*(K_{Ic}/TYS)^2$ (in.)	K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV	DATE	REFER
H1000	Rolled Bar	1.50	R.T.	T-L	205.0	3.000	1.000	CT	---	0.31	72.00	75.0	4.2	1974	90011
		1.50			205.0	3.000	1.000	CT	---	0.36	78.00			1974	90011
H1025	Sheet	5.00	R.T.	L-T	200.0	---	---	NB	---	0.44	84.30	---	---	1972	84365
H1050	Forging	1.50	-65	L-T	194.7	3.008	1.503	CT	1.537	0.44	81.80	78.3	4.8	1987	DA006
		1.50			194.7	3.009	1.504	CT	1.540	0.42	80.20			1987	DA006
		3.00			206.9	2.000	0.998	CT	1.021	0.31	72.80			1987	DA007
H1050	Forging	1.50	-65	T-L	193.6	3.006	1.500	CT	1.550	0.38	75.40	72.4	6.1	1987	DA006
		1.50			193.6	3.009	1.503	CT	1.553	0.39	76.50			1987	DA006
		3.00			206.8	2.000	0.998	CT	1.024	0.25	65.40			1987	DA007
H1050	Forging	2.00	R.T.	L-T	185.4	4.006	1.997	CT	2.100	1.70	152.90	143.3	9.2	1987	DA006
		3.00			196.5	4.009	2.000	CT	2.241	1.31	142.30			1987	DA007
		3.00			196.5	4.008	2.001	CT	2.221	1.17	134.60			1987	DA007
H1050	Forging	3.00	R.T.	T-L	196.9	4.005	2.001	CT	2.198	0.93	120.40	122.0	2.2	1987	DA007
		3.00			196.9	4.007	2.001	CT	2.245	0.98	123.50			1987	DA007
H1050	Rolled Bar	2.25	R.T.	L-T	172.0	2.000	1.000	CT	1.034	0.97	107.30	103.1	4.6	1973	86688
		2.25			172.0	2.000	1.000	CT	1.018	0.81	98.20			1973	86688
		2.25			172.0	2.000	1.000	CT	1.019	0.91	103.90			1973	86688
H1050	Rolled Bar	2.25	R.T.	T-L	178.0	4.000	2.000	CT	2.091	0.81	101.40	94.9	7.8	1973	86688
		2.25			178.0	2.000	1.000	CT	1.032	0.59	86.30			1973	86688
		2.25			178.0	2.000	1.000	CT	1.030	0.61	88.10			1973	86688
		2.25			178.0	4.000	2.000	CT	2.104	0.82	102.10			1973	86688
		2.25			178.0	4.000	2.000	CT	2.105	0.82	102.30			1973	86688
		2.25			178.0	2.000	1.000	CT	1.028	0.62	88.90			1973	86688

TABLE 4.17.2.1 (CONCLUDED)

STAINLESS STEEL PH13-8MO K_{Ic}

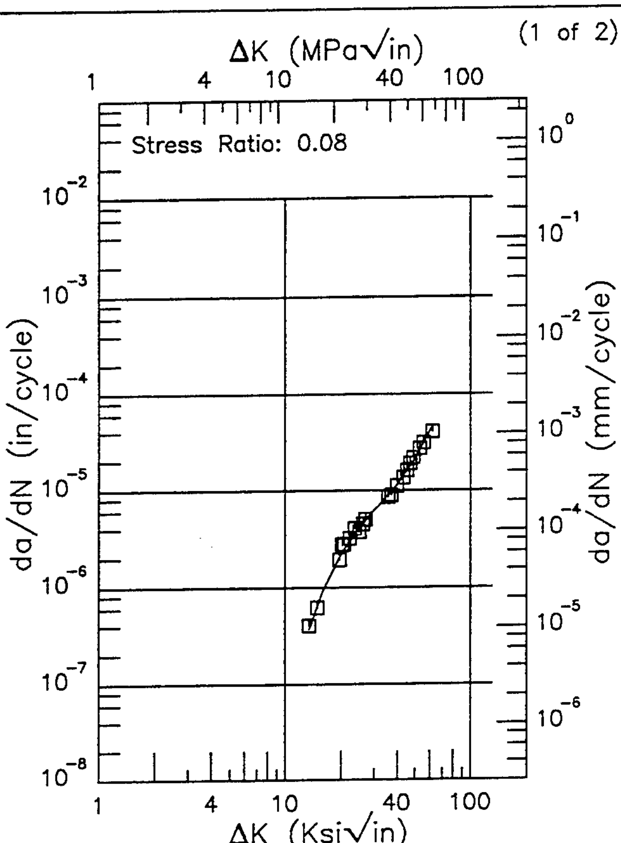
CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * √in.)	K_{Ic} MEAN	STAN DEV		
H1050	Rolled Bar	2.25	R.T.	S-L	176.0	1.500	0.750	CT	0.762	0.64	89.20	92.2	4.2	1973	86688
		2.25			176.0	1.500	0.750	CT	0.781	0.73	95.20			1973	86688
MILL 1700F LAB 1050F 4HR	Forging	5.00	-65	L-T	195.0	2.996	1.500	CT	1.546	0.41	78.80	---	---	1973	85836
MILL 1700F LAB 1600F 1000F 4 HR	Forging	5.00	-65	L-T	195.0	2.008	1.000	CT	1.060	0.30	67.60	---	---	1973	85836
MILL 1700F LAB 1500F 1000F 4 HR	Forging	5.00	-65	L-T	195.0	2.006	0.999	CT	1.052	0.34	72.50	---	---	1973	85836
RH 950	Rolled Bar	1.50	R.T.	L-R	210.0	1.000	0.500	CT	---	0.18	57.00	59.8	2.2	1974	90011
		1.50			210.0	1.000	0.500	CT	---	0.20	59.00			1974	90011
		1.50			210.0	1.000	0.500	CT	---	0.21	61.00			1974	90011
		1.50			210.0	1.000	0.500	CT	---	0.22	62.00			1974	90011
RH 975	Rolled Bar	1.50	R.T.	L-R	207.0	1.000	0.500	CT	---	0.25	66.00	70.0	5.3	1974	90011
		1.50			207.0	1.000	0.500	CT	---	0.34	76.00			1974	90011
		1.50			207.0	1.000	0.500	CT	---	0.30	68.00			1974	90011
RH1000	Rolled Bar	1.50	R.T.	L-R	205.0	1.000	0.500	CT	---	0.54	95.00	---	---	1974	90011

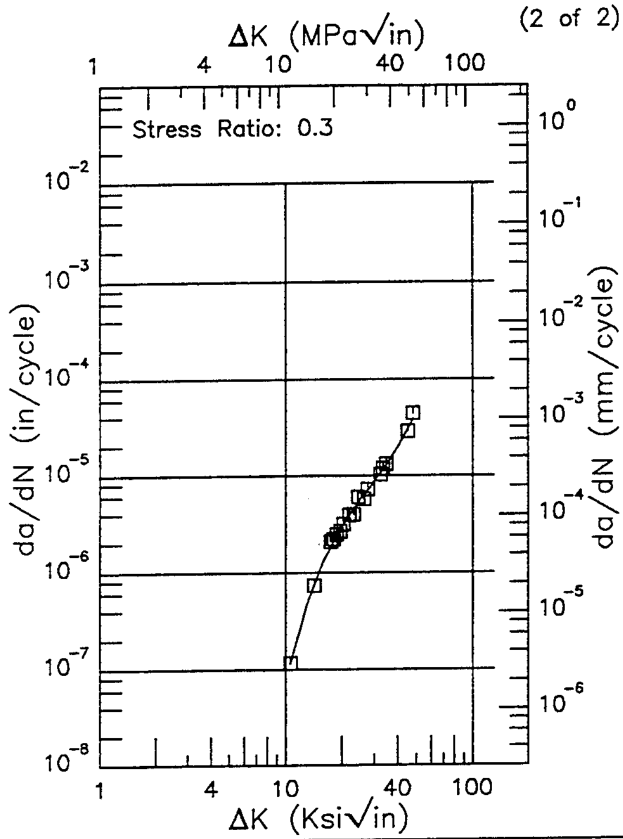
R

PH13-8Mo

Condition/Ht:
Form: Extruded Bar
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 201 ksi
Ult. Strength: 212 ksi
Specimen Thk: 0.26 in.
Specimen Width: 6 in.
Ref: 88579

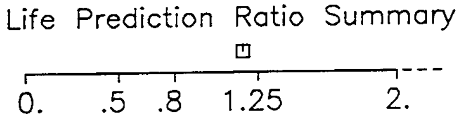




ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.43 (min)	0.370
16.	0.936
20.	2.22
25.	4.12
30.	6.17
35.	8.51
40.	11.4
50.	20.8
60.	40.2
61.76 (max)	45.5

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.60 (min)	0.114
13.	0.463
16.	1.32
20.	2.98
25.	5.56
30.	8.77
35.	13.1
40.	19.6
48.07 (max)	38.4

RMS % Error: 8.70



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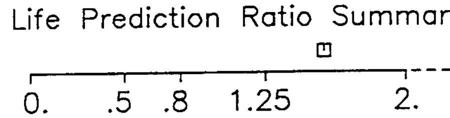
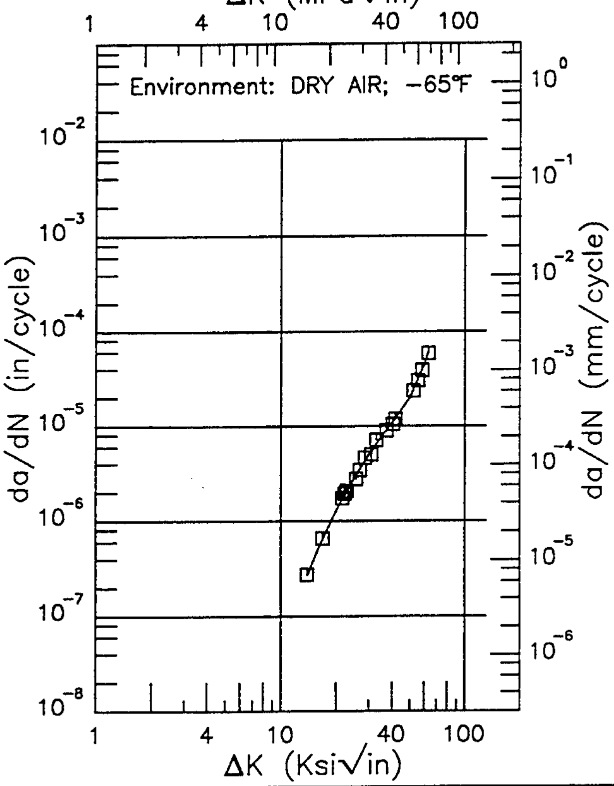


Figure 4.17.3.1.1

Condition/Ht:
Form: Extruded Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 6 Hz

Yield Strength: 201 ksi
Ult. Strength: 212 ksi
Specimen Thk: 0.26 in.
Specimen Width: 6 in.
Ref: 88579

(1 of 2)



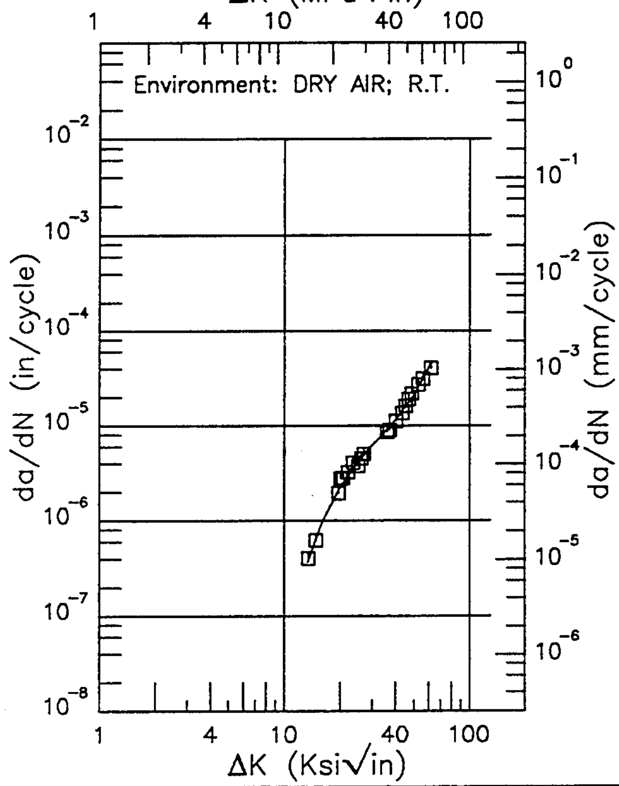
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.84 (min)	0.271
16.	0.520
20.	1.28
25.	2.82
30.	4.98
35.	7.67
40.	10.8
50.	20.0
60.	44.7
62.88 (max)	59.2

RMS % Error: 4.66

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
13.43 (min)	0.370
16.	0.936
20.	2.22
25.	4.12
30.	6.17
35.	8.51
40.	11.4
50.	20.8
60.	40.2
61.76 (max)	45.5

RMS % Error: 8.70

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

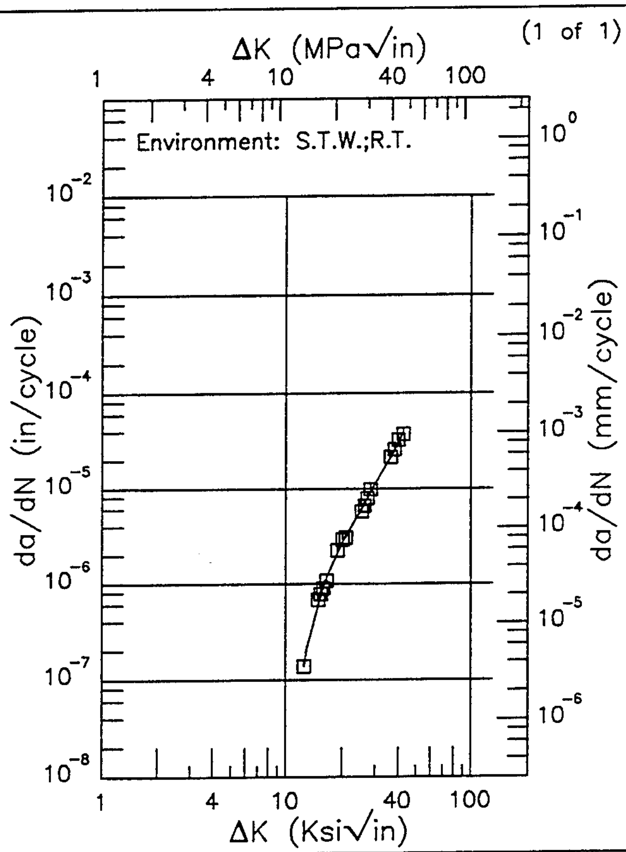
Figure 4.17.3.1.2

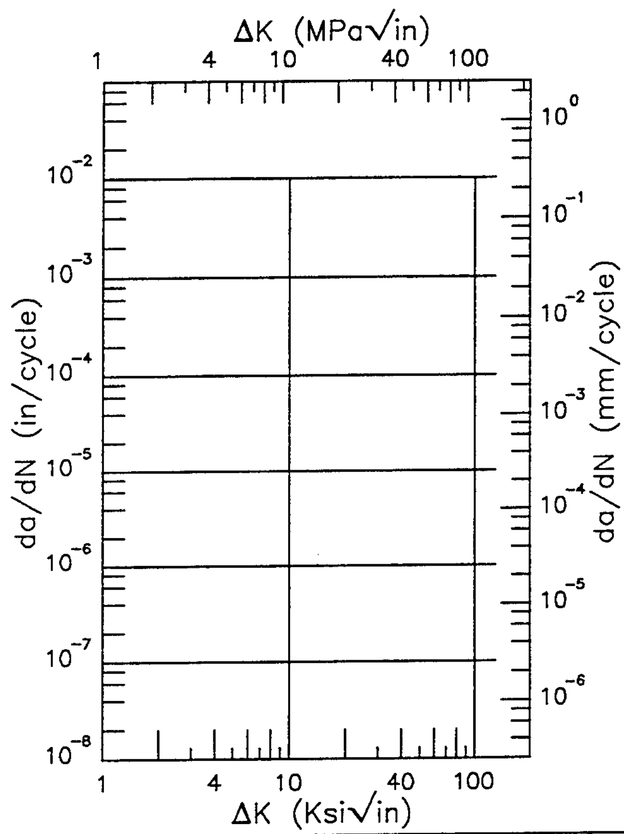
E PH13-8Mo

Condition/Ht:
Form: Extruded Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 1 Hz

Yield Strength: 201 ksi
Ult. Strength: 212 ksi
Specimen Thk: 0.25 in.
Specimen Width: 6 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.50 (min)	0.138
13.	0.209
16.	1.02
20.	2.69
25.	5.86
30.	11.4
35.	19.1
40.	30.3
42.46 (max)	38.9

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
6.88	0. .5 .8 1.25 2.

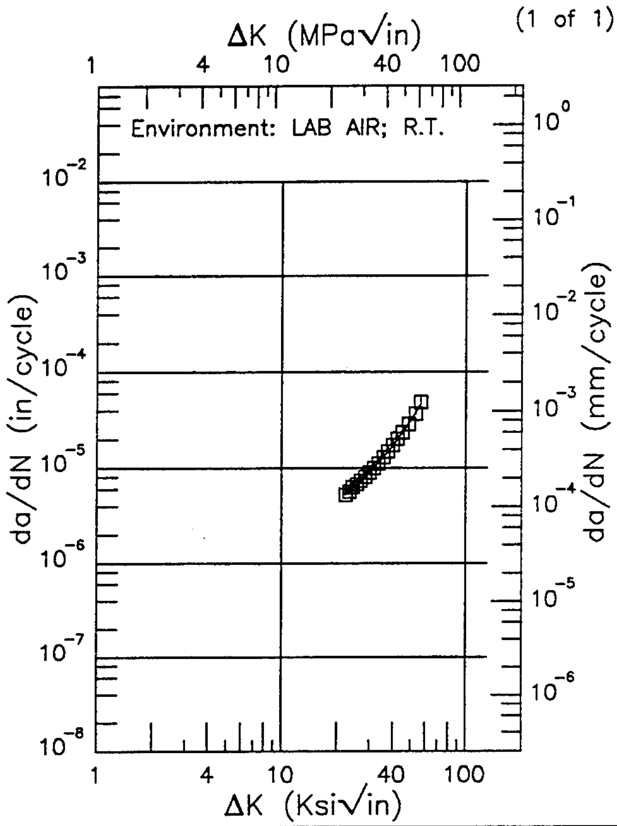
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

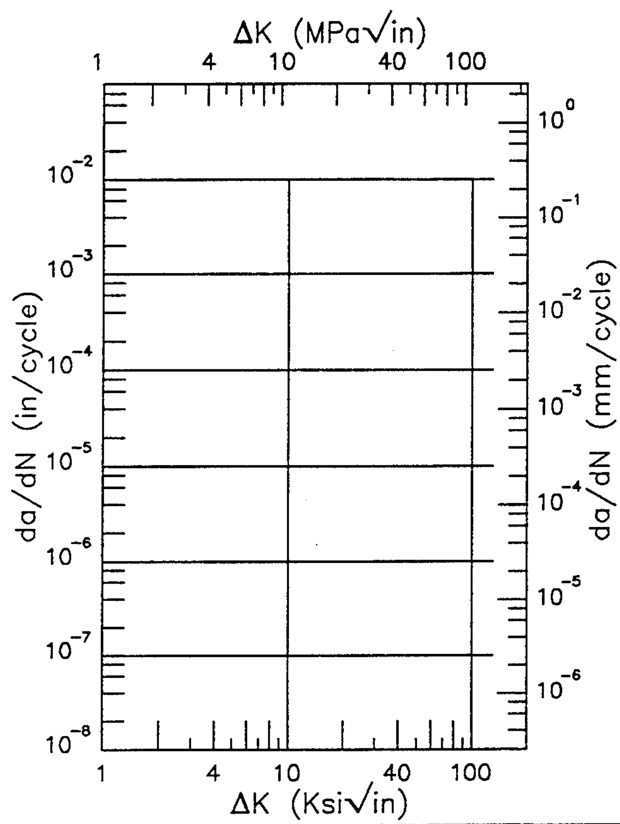
Figure 4.17.3.1.3

Condition/Ht: H1000
Form: 2.5 in. Bar
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.02
Frequency: 10 Hz

Yield Strength: 205 ksi
Ult. Strength: 211.5 ksi
Specimen Thk: 1.25 in.
Specimen Width: 5 in.
Ref: 88136

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
22.06 (min)	5.28
25.	6.49
30.	9.06
35.	12.5
40.	17.1
50.	31.6
56.54 (max)	46.7

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
1.57	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

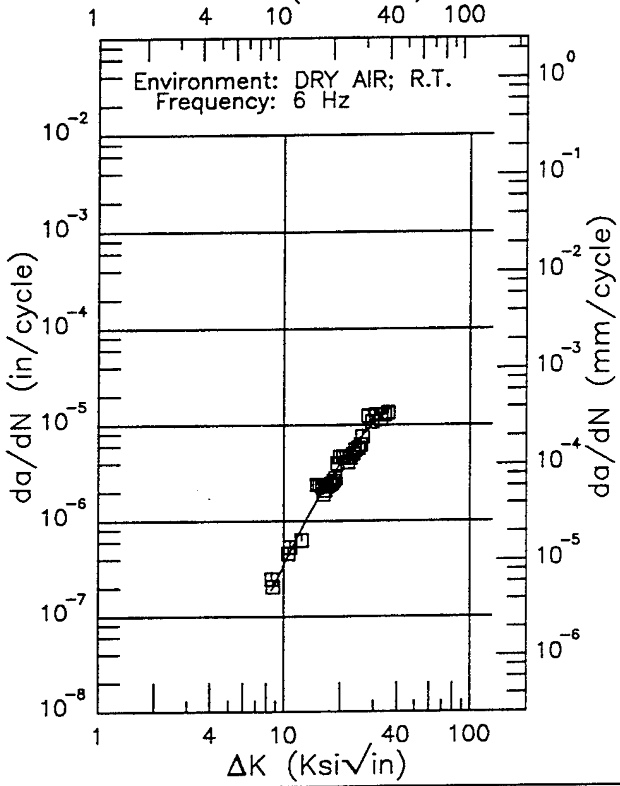
Figure 4.17.3.1.4

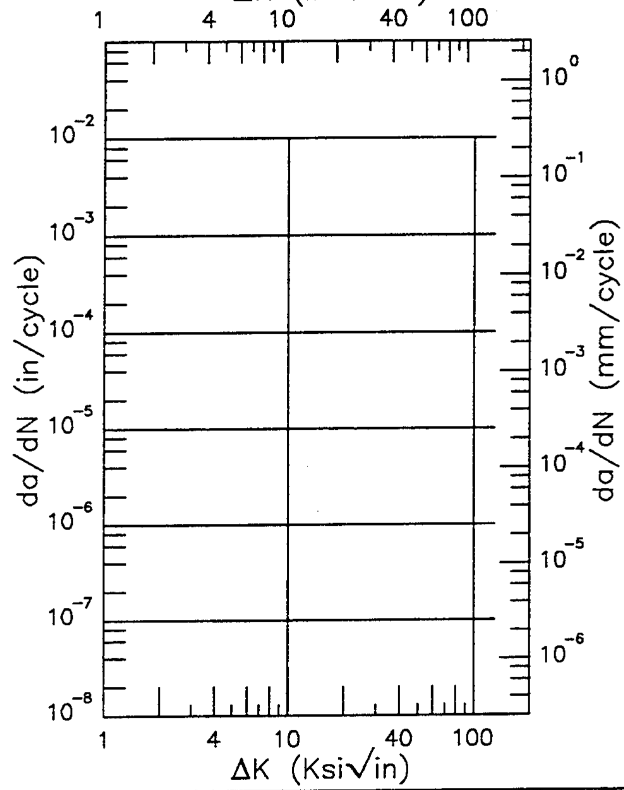
EF PH13–8Mo

Condition/Ht: H1000
Form: 6 in. Billet
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.08

Yield Strength: 191 ksi
Ult. Strength: 208 ksi
Specimen Thk: 0.997 in.
Specimen Width: 6.191 in.
Ref: 85837

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.54 (min)	0.187
9.	0.234
10.	0.360
13.	0.983
16.	2.01
20.	3.97
25.	7.09
30.	10.5
35.	13.7
35.80 (max)	14.2

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
17.86	0. .5 .8 1.25 2.

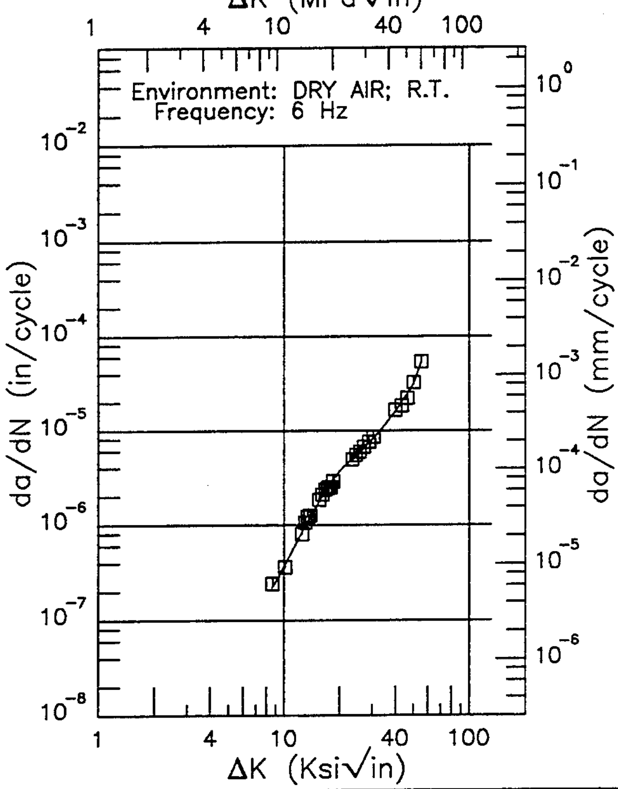
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

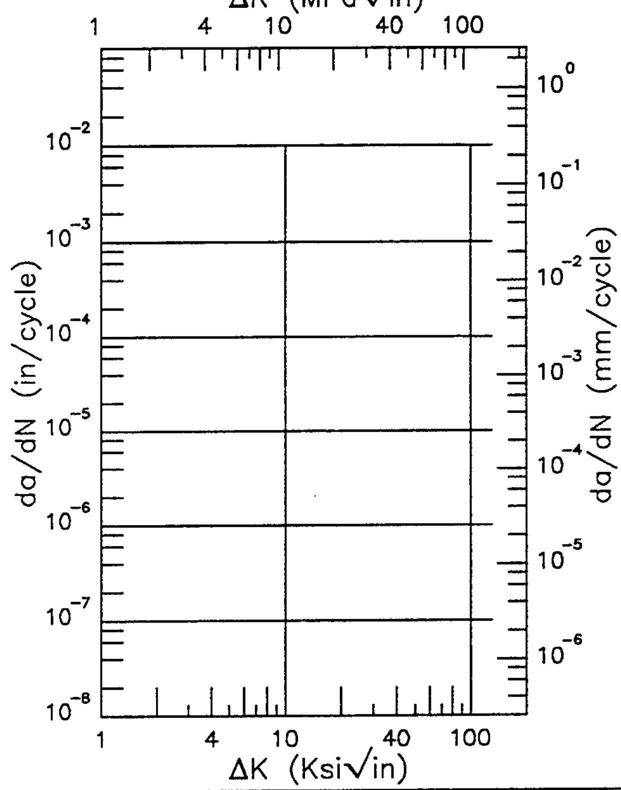
Figure 4.17.3.1.5

Condition/Ht: H1000
Form: 22 in. Billet
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.08

Yield Strength: 190 ksi
Ult. Strength: 207 ksi
Specimen Thk: 1 in.
Specimen Width: 4.94 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
8.63 (min)	0.222
9.	0.256
10.	0.370
13.	0.959
16.	1.95
20.	3.66
25.	5.74
30.	8.06
35.	11.5
40.	16.2
50.	30.7
55.15 (max)	54.4

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)

RMS % Error
6.32

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

RMS % Error

Life Prediction Ratio Summary
0. .5 .8 1.25 2.

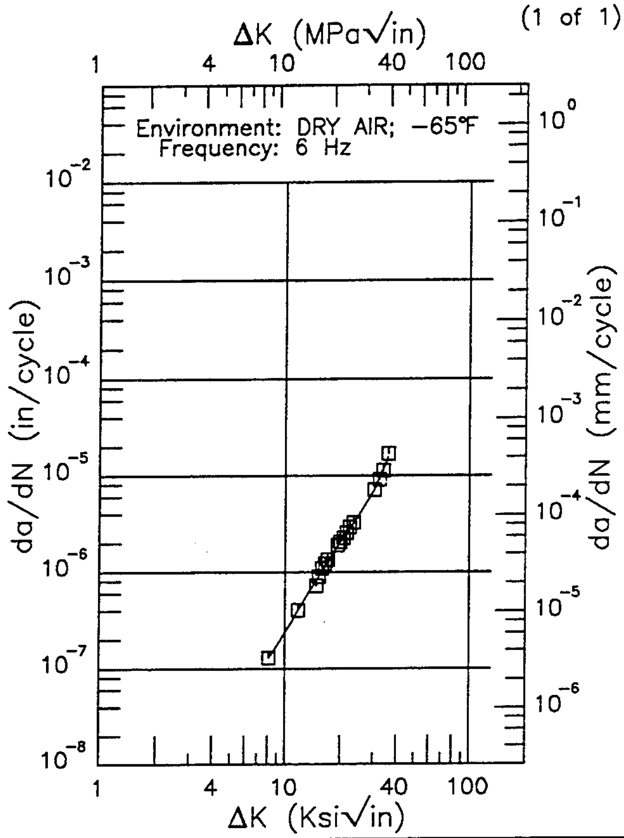
Figure 4.17.3.1.6

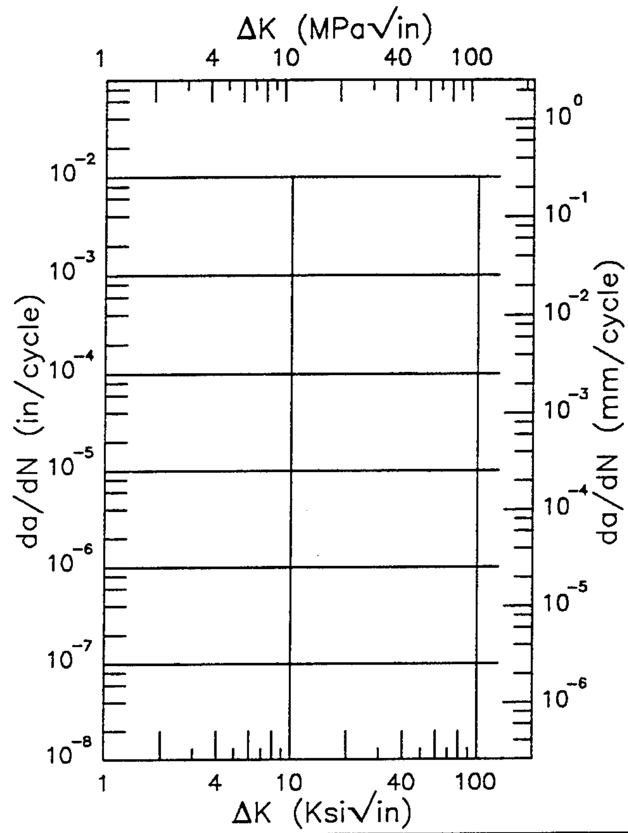
EF PH13–8Mo

Condition/Ht: H1000
Form: 6 in. Billet
Specimen Type: CT
Orientation: S–T
Stress Ratio: 0.08

Yield Strength: 190 ksi
Ult. Strength: 207 ksi
Specimen Thk: 1 in.
Specimen Width: 4.94 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.14 (min)	0.129
9.	0.173
10.	0.239
13.	0.546
16.	1.05
20.	2.07
25.	3.84
30.	6.83
35.	13.6
35.96 (max)	15.7

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
4.75

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

RMS % Error

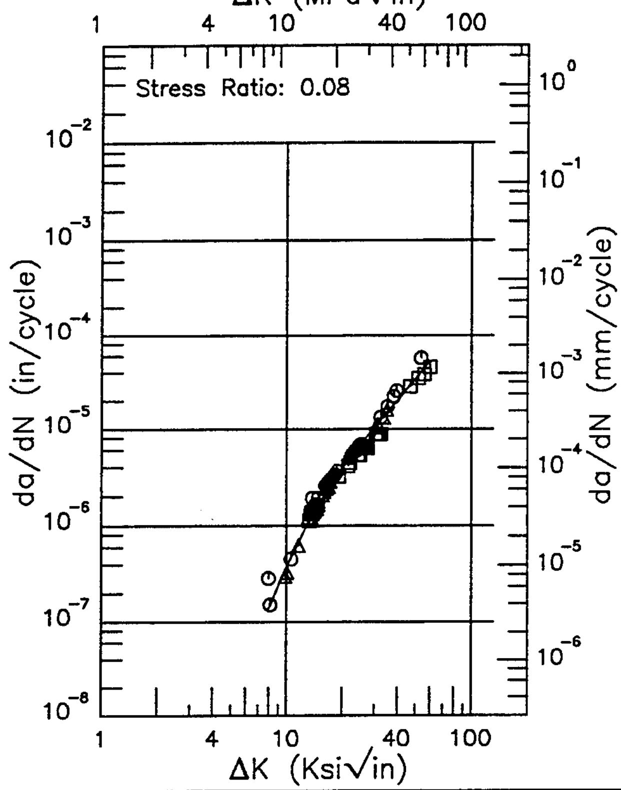
Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.17.3.1.7

Condition/Ht: H1000
Form: 1.5 in. Extruded Bar
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: DRY AIR; RT

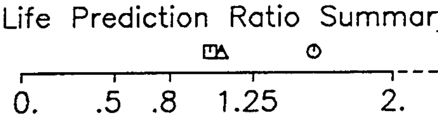
Yield Strength: 214 ksi
Ult. Strength: 221 ksi
Specimen Thk: 1 in.
Specimen Width: 6.17 – 6.18 in.
Ref: 88579

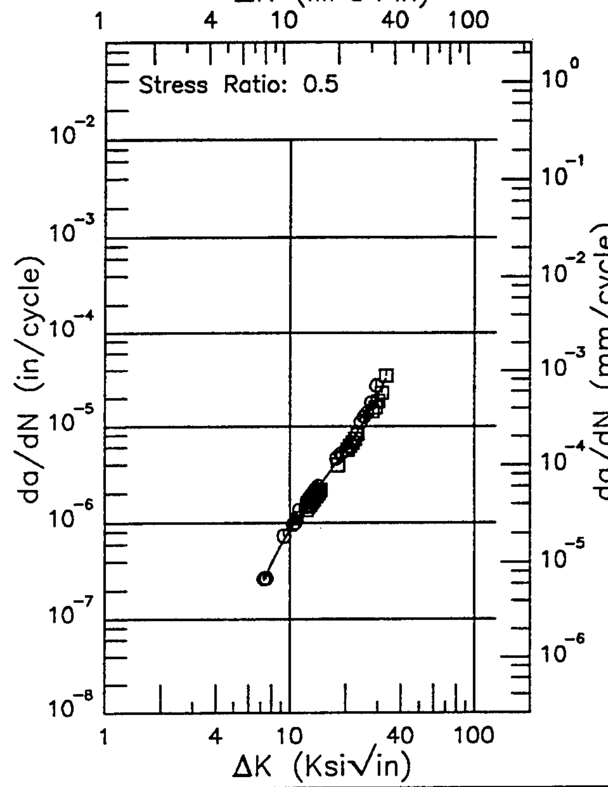


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.96 (min)	0.135
8.	0.138
9.	0.241
10.	0.381
13.	1.04
16.	2.04
20.	3.86
25.	6.83
30.	10.5
35.	15.0
40.	20.3
50.	34.1
59.52 (max)	52.4

RMS % Error
21.06

Life Prediction Ratio Summary





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.25 (min)	0.254
8.	0.383
9.	0.593
10.	0.842
13.	1.79
16.	3.08
20.	5.58
25.	11.0
30.	21.4
33.12 (max)	32.4

RMS % Error
11.09

Life Prediction Ratio Summary

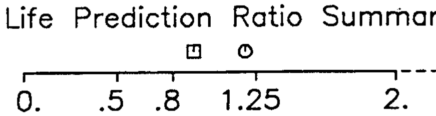


Figure 4.17.3.1.8

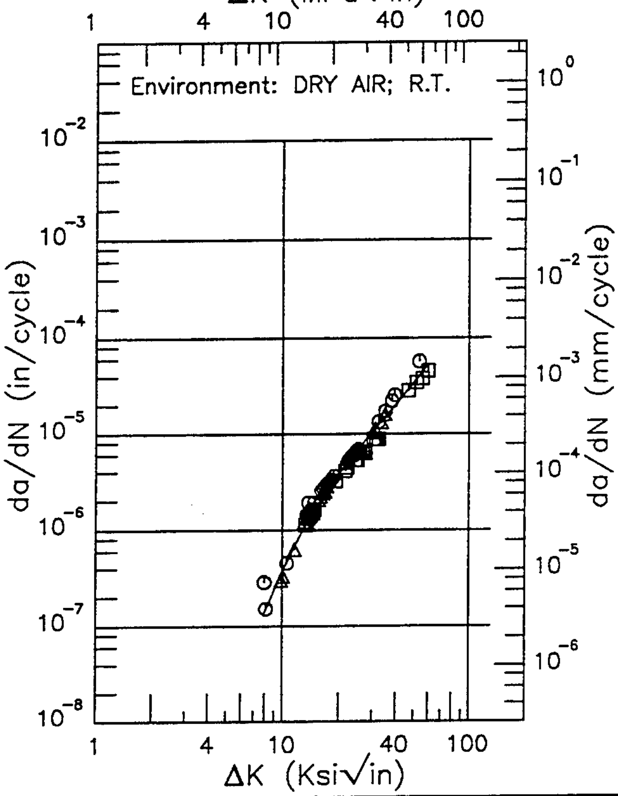
PH13-8Mo

E

Condition/Ht: H1000
Form: 1.5 in. Extruded Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 6 Hz

Yield Strength: 208 - 214 ksi
Ult. Strength: 216 - 221 ksi
Specimen Thk: 0.999 - 1 in.
Specimen Width: 6.17 - 6.18 in.
Ref: 88579;85837

(1 of 2)



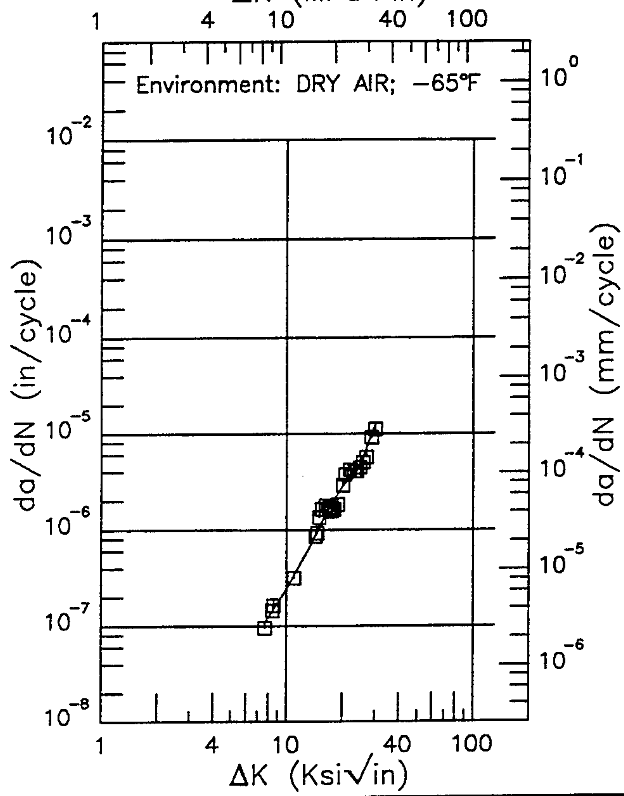
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.96 (min)	0.135
8.	0.138
9.	0.241
10.	0.381
13.	1.04
16.	2.04
20.	3.86
25.	6.83
30.	10.5
35.	15.0
40.	20.3
50.	34.1
59.52 (max)	52.4

RMS % Error: 21.06

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.62 (min)	0.106
8.	0.122
9.	0.173
10.	0.242
13.	0.607
16.	1.34
20.	2.81
25.	4.75
29.92 (max)	12.3

RMS % Error: 15.05

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

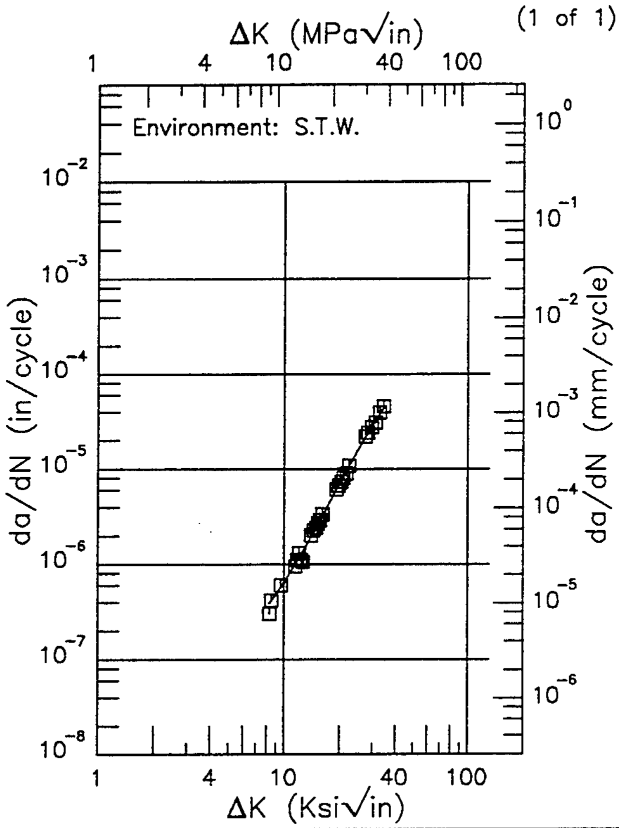
Figure 4.17.3.1.9

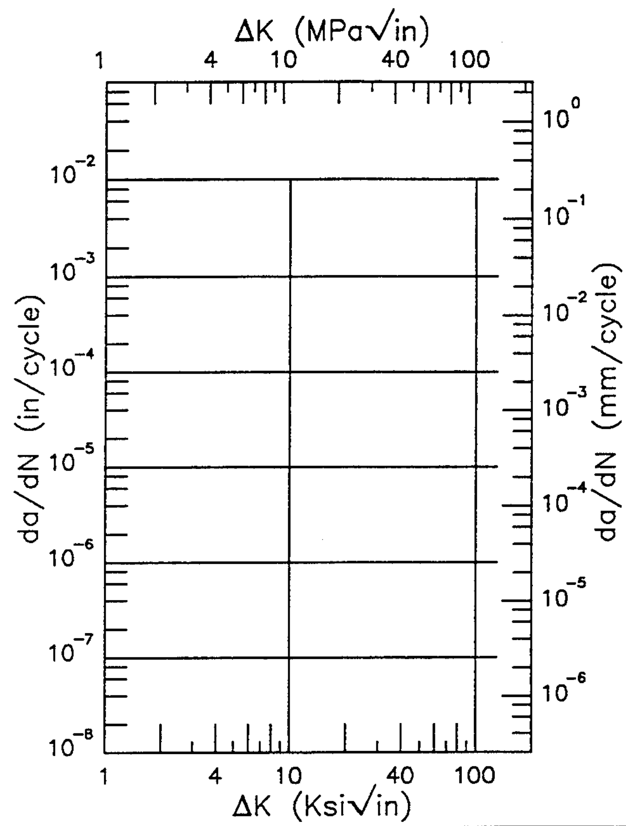
PH13–8Mo E

Condition/Ht: H1000
Form: 1.5 in. Extruded Bar
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.08
Frequency: 1 Hz

Yield Strength: 214 ksi
Ult. Strength: 221 ksi
Specimen Thk: 1 in.
Specimen Width: 6.18 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.27 (min)	0.388
9.	0.479
10.	0.643
13.	1.49
16.	3.13
20.	7.11
25.	15.8
30.	29.0
34.43 (max)	43.7

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
7.75	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.10

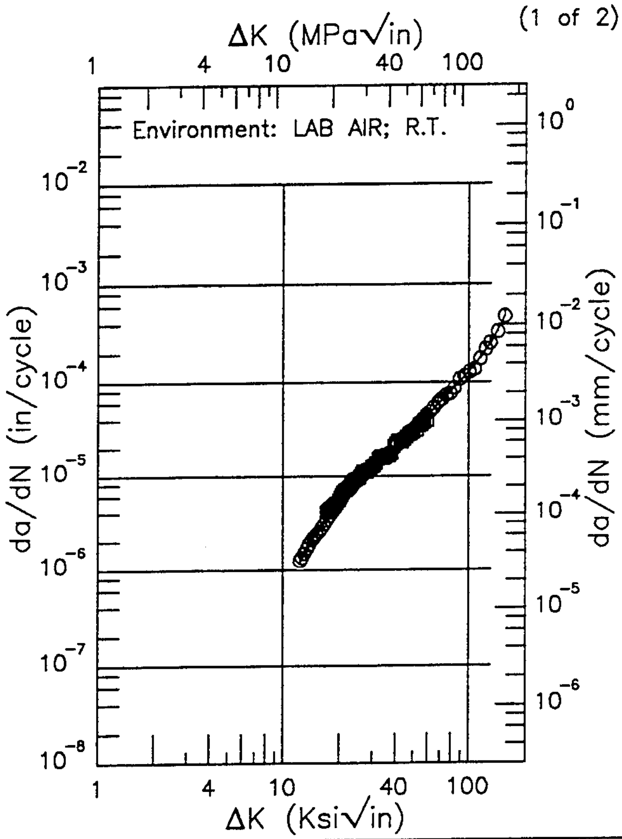
E

PH13-8Mo

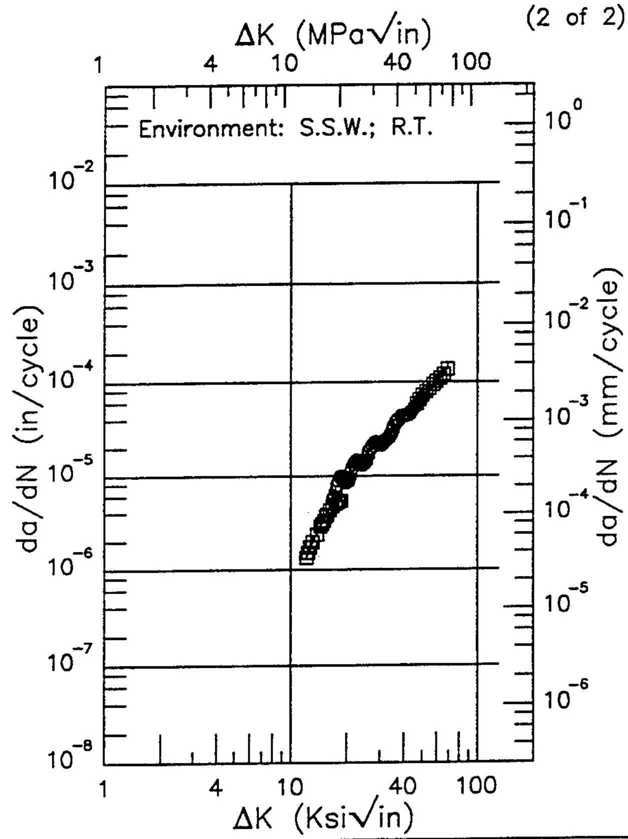
Condition/Ht: H1000
Form: 3 in. Forging
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.1
Frequency: 1 - 10 Hz

Yield Strength: 206 ksi
Ult. Strength: 210.6 ksi
Specimen Thk: 1.003 - 1.005 in.
Specimen Width: 4.5 - 7.4 in.
Ref: NC002

(1 of 2)



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.29 (min)	1.14
13.	1.45
16.	3.06
20.	5.70
25.	9.23
30.	12.8
35.	16.6
40.	20.7
50.	30.8
60.	44.5
70.	61.7
80.	81.4
90.	103.
100.	127.
130.	252.
154.80 (max)	464.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.13 (min)	1.30
13.	1.82
16.	4.36
20.	9.07
25.	16.1
30.	23.9
35.	32.3
40.	41.8
50.	65.5
60.	99.7
69.01 (max)	145.

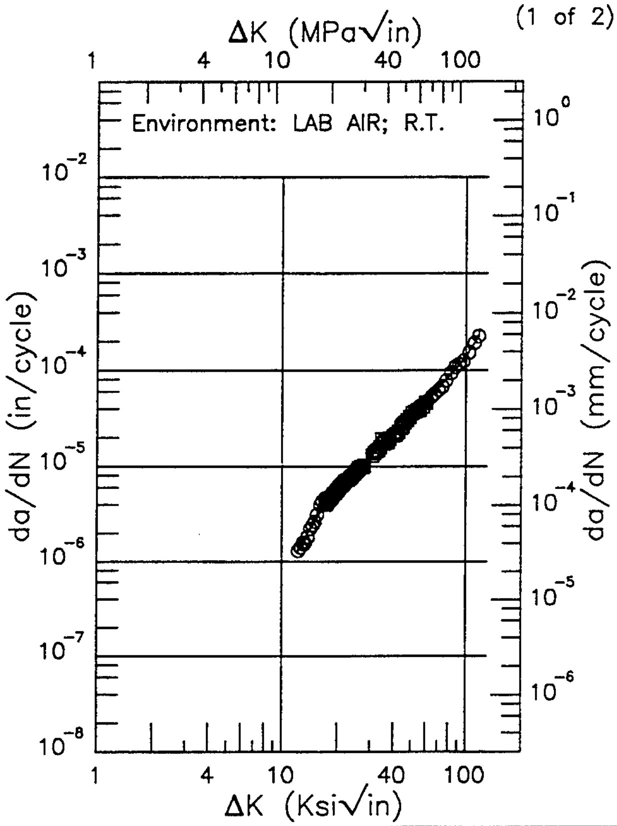
RMS % Error	Life Prediction Ratio Summary
5.26	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
11.78	0. .5 .8 1.25 2.

Figure 4.17.3.1.11

Condition/Ht: H1000	Yield Strength: 205.4 ksi
Form: 3 in. Forging	Ult. Strength: 210.8 ksi
Specimen Type: CT	Specimen Thk: 1.003 – 1.005 in.
Orientation: T-L	Specimen Width: 4.5 – 7.4 in.
Stress Ratio: 0.1	Ref: NC002
Frequency: 1 – 10 Hz	

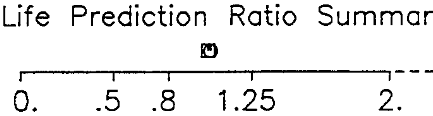
(1 of 2)



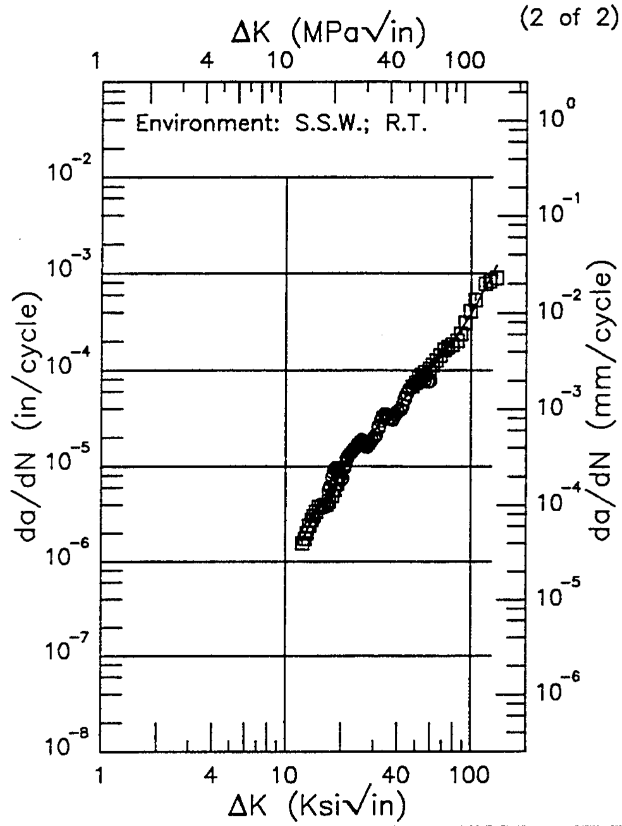
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.18 (min)	1.28
13.	1.64
16.	3.23
20.	5.74
25.	9.12
30.	12.7
35.	16.5
40.	20.8
50.	31.6
60.	46.3
70.	64.7
80.	85.9
90.	110.
100.	140.
116.68 (max)	228.

RMS % Error: 6.44

Life Prediction Ratio Summary



(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.34 (min)	1.67
13.	2.05
16.	4.32
20.	8.51
25.	15.2
30.	23.1
35.	32.2
40.	42.6
50.	67.9
60.	101.
70.	145.
80.	203.
90.	281.
100.	385.
130.	952.
137.87 (max)	1199.

RMS % Error: 14.28

Life Prediction Ratio Summary

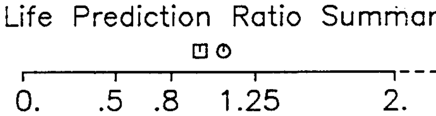


Figure 4.17.3.1.12

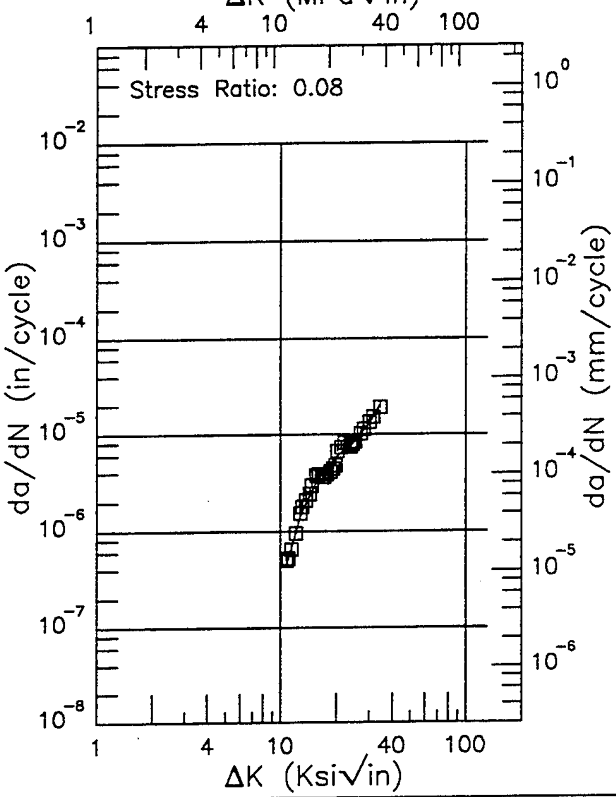
PH13-8Mo

R

Condition/Ht: H1000
Form: 4 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 201 ksi
Ult. Strength: 212 ksi
Specimen Thk: 0.99 – 0.998 in.
Specimen Width: 6 in.
Ref: 85837;88579

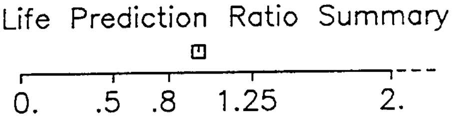
(1 of 3)



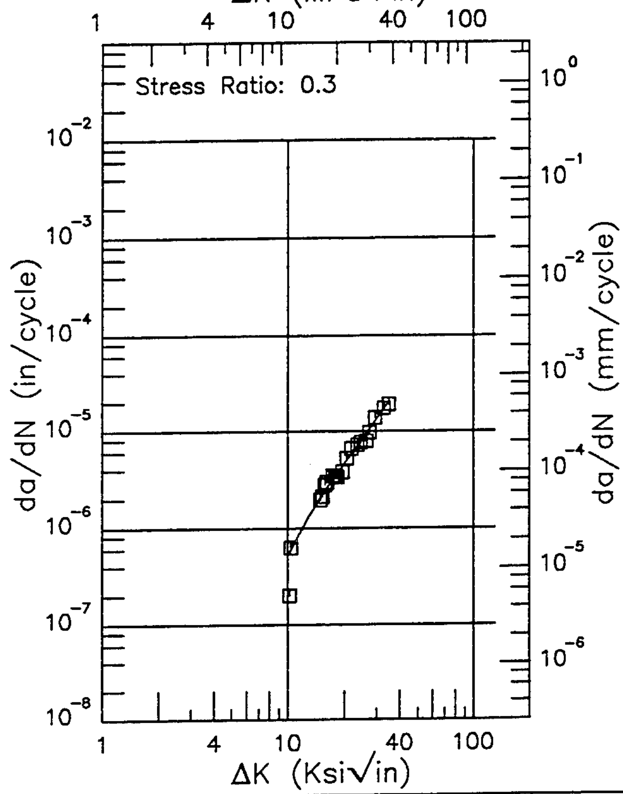
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.78 (min)	0.447
13.	1.52
16.	3.49
20.	5.82
25.	8.52
30.	12.7
34.32 (max)	19.9

RMS % Error
10.41

Life Prediction Ratio Summary



(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.25 (min)	0.567
13.	1.33
16.	2.51
20.	4.63
25.	8.26
30.	13.4
34.71 (max)	20.0

RMS % Error
17.38

Life Prediction Ratio Summary

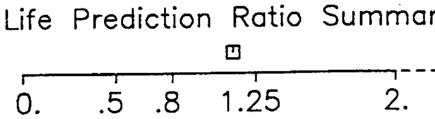
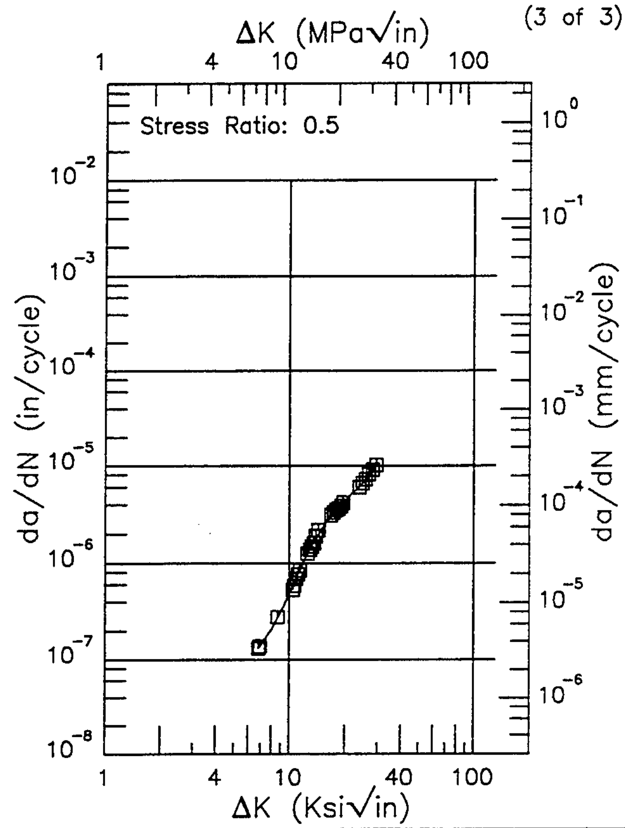


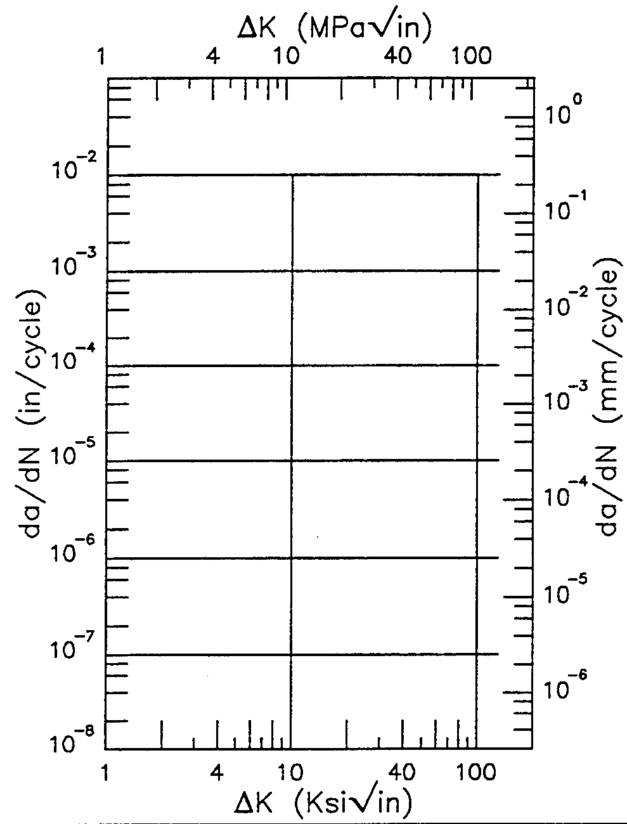
Figure 4.17.3.1.13

Condition/Ht: H1000
Form: 4 in. Forged Bar
Specimen Type: CT
Orientation: L–T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 201 ksi
Ult. Strength: 212 ksi
Specimen Thk: 0.99 – 0.998 in.
Specimen Width: 6 in.
Ref: 85837;88579

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.81 (min)	0.133
7.	0.141
8.	0.204
9.	0.314
10.	0.486
13.	1.45
16.	2.77
20.	4.36
25.	6.69
29.25 (max)	10.3

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
3.88	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

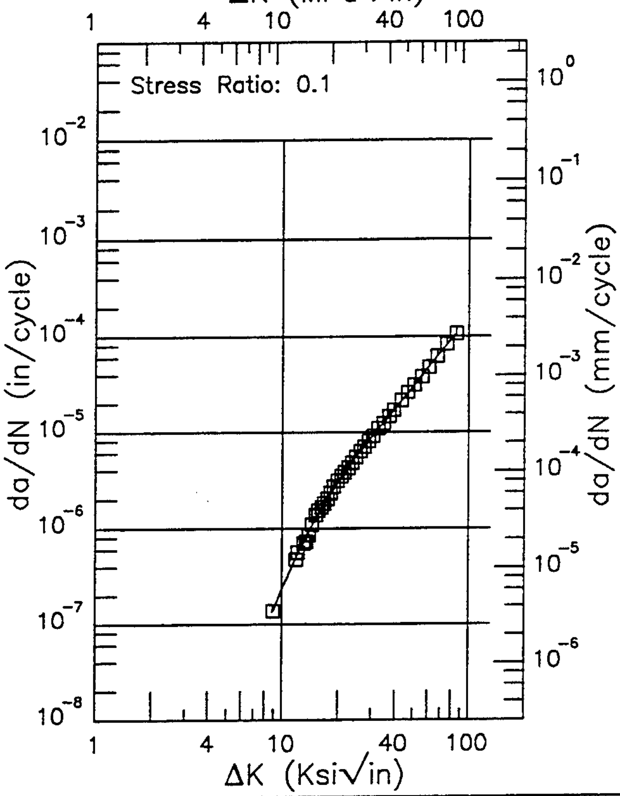
Figure 4.17.3.1.13 (Concluded)

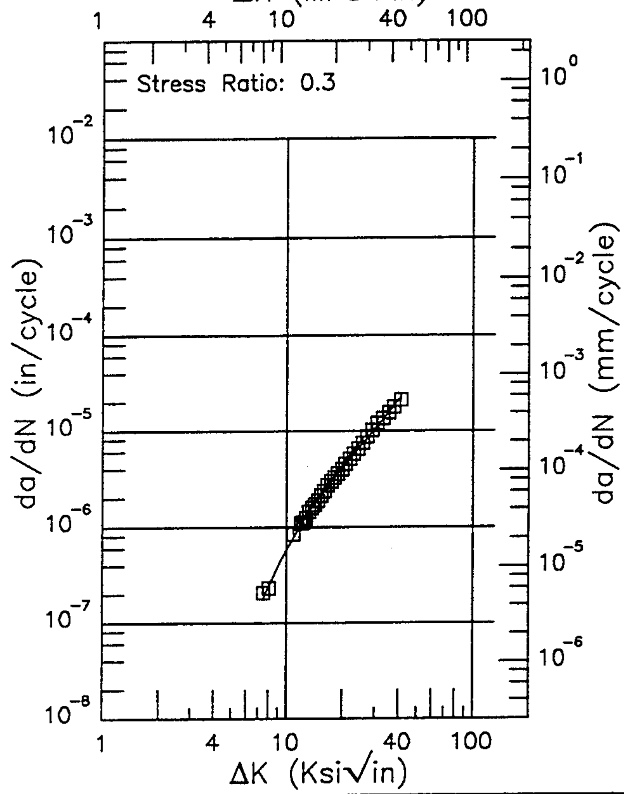
PH13-8Mo

R

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 215 ksi
Ult. Strength: 221 ksi
Specimen Thk: 0.5 - 0.502 in.
Specimen Width: 3.987 - 3.992 in.
Ref: GD009



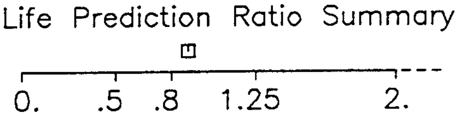


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.91 (min)	0.135
9.	0.142
10.	0.238
13.	0.732
16.	1.54
20.	3.08
25.	5.64
30.	8.86
35.	12.8
40.	17.5
50.	29.9
60.	47.0
70.	68.4
80.	93.5
85.01 (max)	107.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.44 (min)	0.177
8.	0.244
9.	0.393
10.	0.582
13.	1.36
16.	2.41
20.	4.17
25.	6.96
30.	10.5
35.	15.1
40.	21.1
40.86 (max)	22.2

RMS % Error
4.08

Life Prediction Ratio Summary



RMS % Error
5.04

Life Prediction Ratio Summary

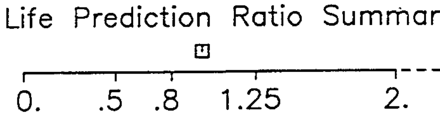
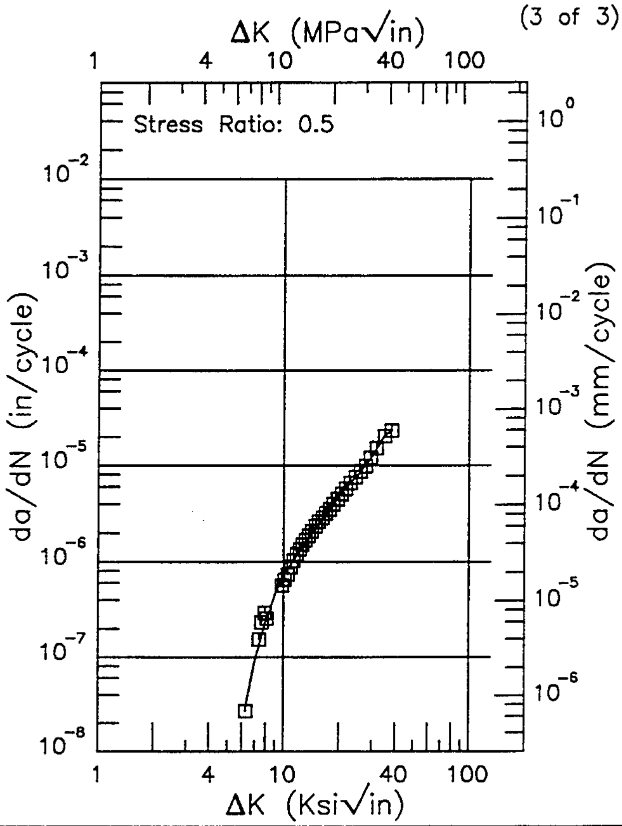


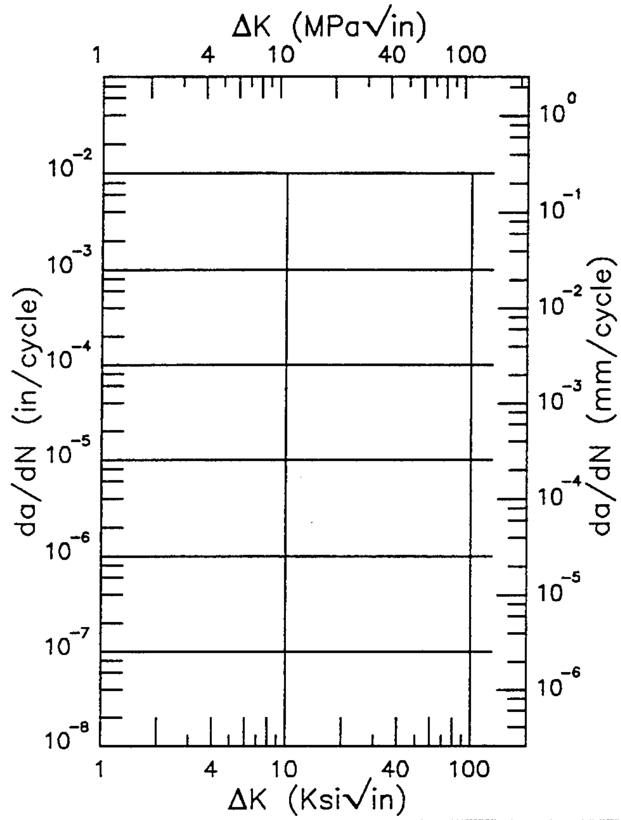
Figure 4.17.3.1.14

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 215 ksi
Ult. Strength: 221 ksi
Specimen Thk: 0.5 – 0.502 in.
Specimen Width: 3.987 – 3.992 in.
Ref: GD009

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.27 (min)	0.0304
7.	0.0889
8.	0.240
9.	0.458
10.	0.711
13.	1.54
16.	2.68
20.	4.93
25.	7.93
30.	12.4
35.	20.7
37.95 (max)	22.9

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
11.05	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.14 (Concluded)

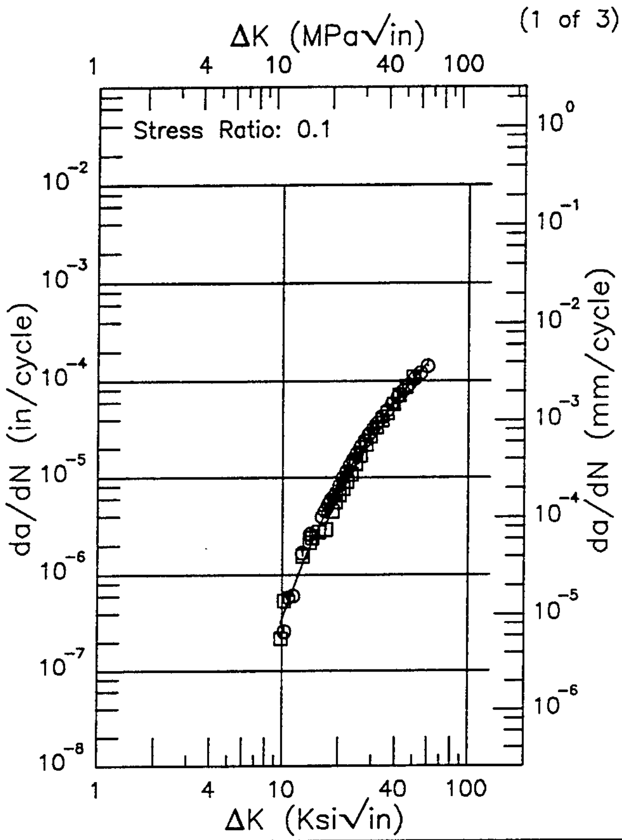
PH13-8Mo

R

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 1 Hz
Environment: H.H.A.; RT

Yield Strength: 215 ksi
Ult. Strength: 221 ksi
Specimen Thk: 0.501 – 0.504 in.
Specimen Width: 3.986 – 4.006 in.
Ref: GD009

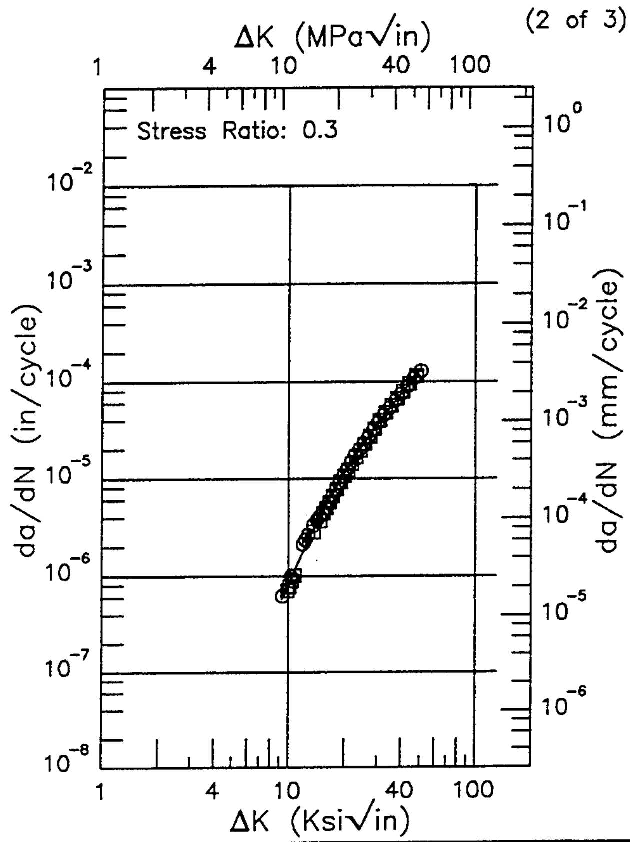
(1 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.78 (min)	0.316
10.	0.359
13.	1.38
16.	3.46
20.	8.11
25.	17.0
30.	29.0
35.	43.7
40.	61.0
50.	103.
59.32 (max)	150.

RMS % Error	Life Prediction Ratio Summary
14.83	0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.28 (min)	0.576
10.	0.818
13.	2.50
16.	5.41
20.	11.3
25.	21.9
30.	36.0
35.	53.6
40.	74.8
50.	129.
50.68 (max)	134.

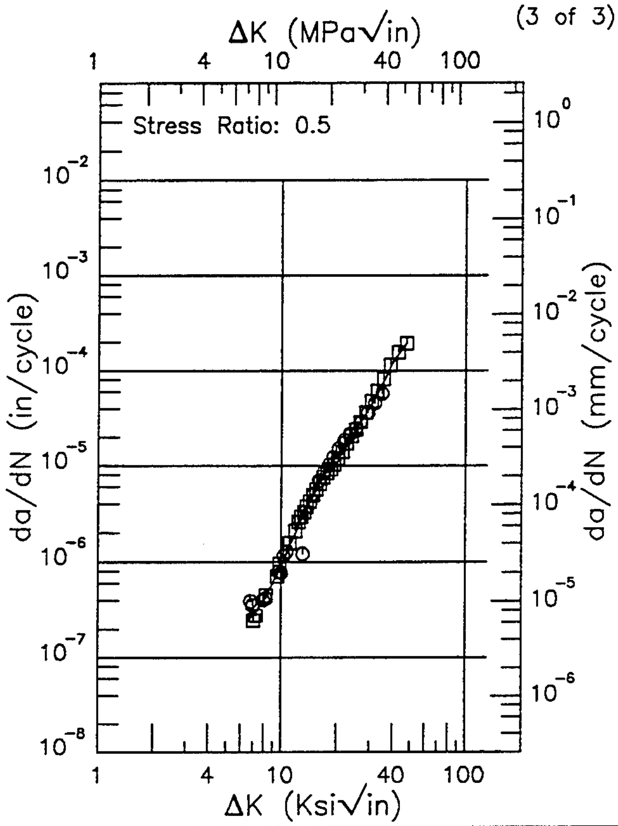
RMS % Error	Life Prediction Ratio Summary
6.70	0. .5 .8 1.25 2.

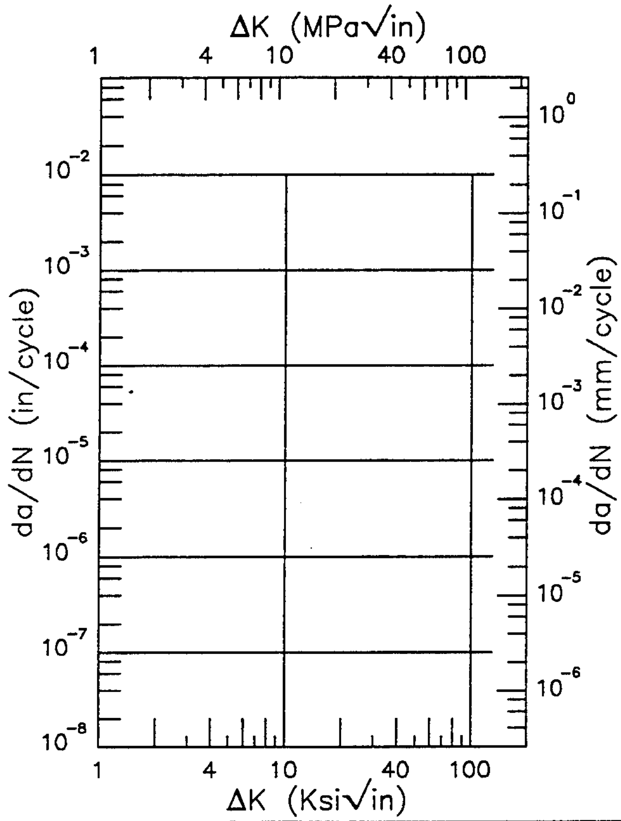
Figure 4.17.3.1.15

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Frequency: 1 Hz
Environment: H.H.A.; RT

Yield Strength: 215 ksi
Ult. Strength: 221 ksi
Specimen Thk: 0.501 – 0.504 in.
Specimen Width: 3.986 – 4.006 in.
Ref: GD009

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.78 (min)	0.265
7.	0.283
8.	0.403
9.	0.604
10.	0.913
13.	2.79
16.	6.42
20.	13.0
25.	23.5
30.	41.0
35.	71.9
40.	124.
47.33 (max)	191.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
13.20	□○ 0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

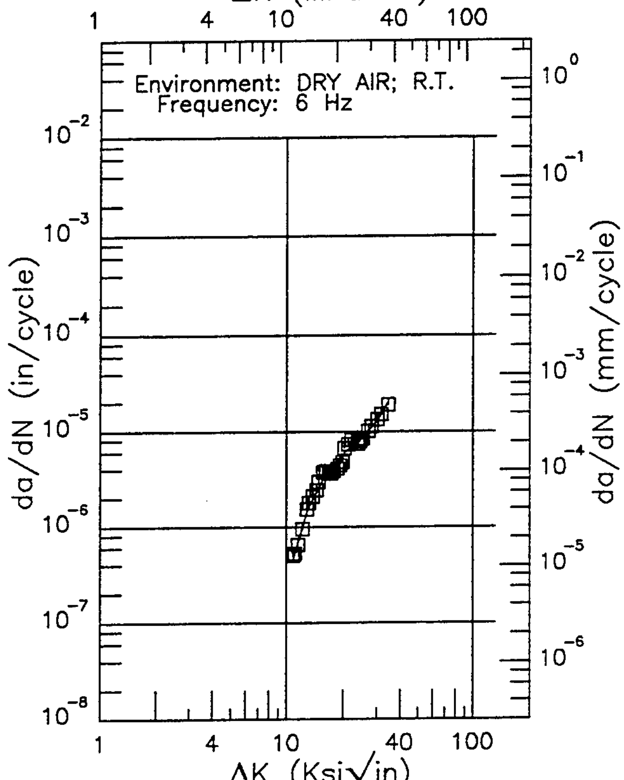
Figure 4.17.3.1.15 (Concluded)

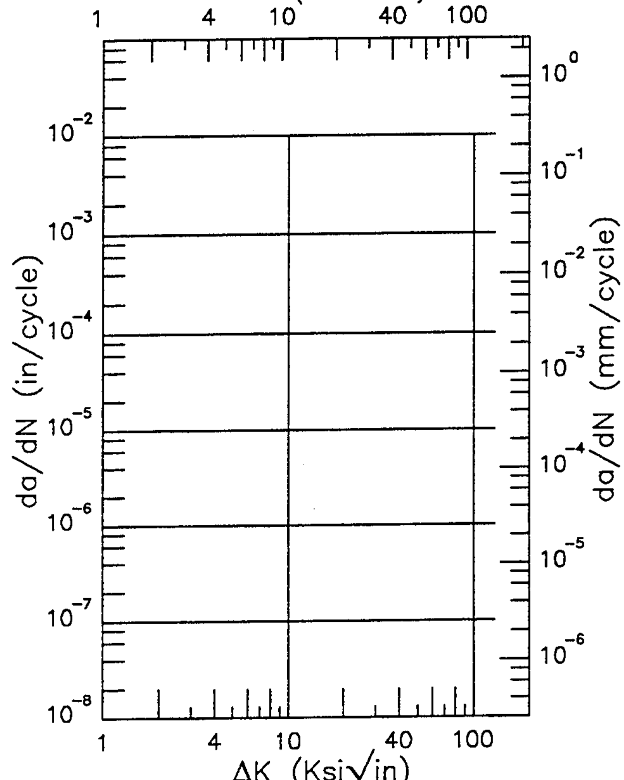
EF PH13-8Mo

Condition/Ht: H1000
Form: 4 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08

Yield Strength: 201 ksi
Ult. Strength: 212 ksi
Specimen Thk: 0.998 in.
Specimen Width: 6 in.
Ref: 85837

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.78 (min)	0.447
13.	1.52
16.	3.49
20.	5.82
25.	8.52
30.	12.7
34.32 (max)	19.9

ΔK (Ksi√in) da/dN (10^{-6}in/cycle)

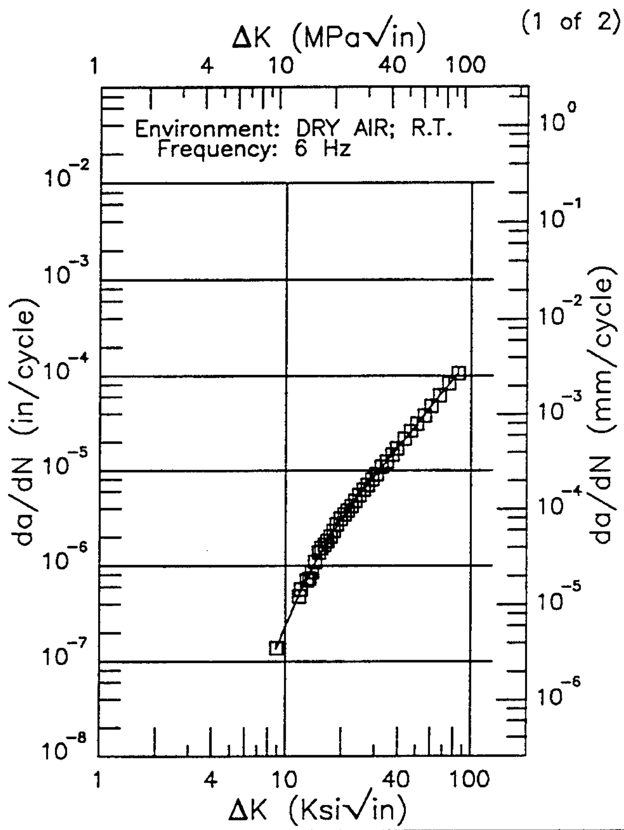
RMS % Error	Life Prediction Ratio Summary
10.41	0. .5 .8 1.25 2.

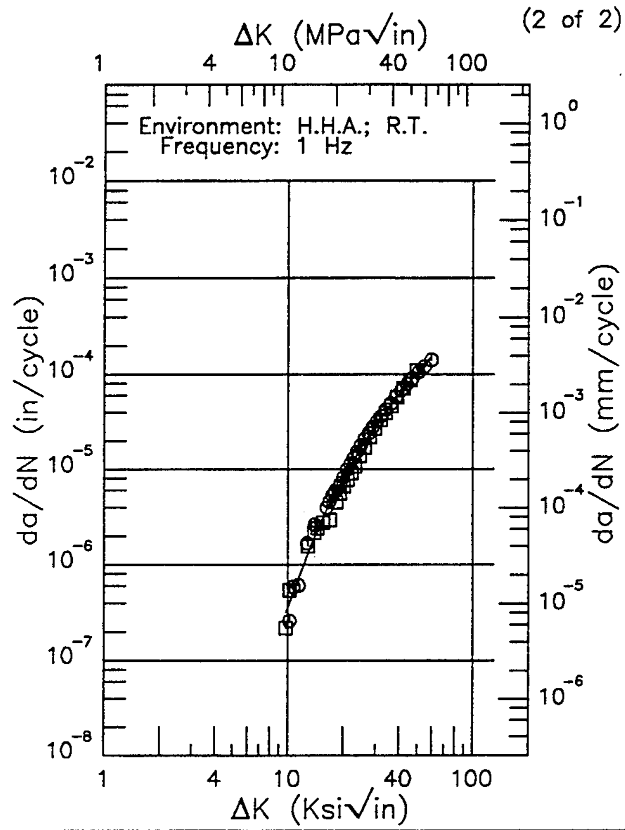
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.16

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.1

Yield Strength: 215 ksi
Ult. Strength: 221 ksi
Specimen Thk: 0.501 – 0.504 in.
Specimen Width: 3.986 – 3.99 in.
Ref: GD009

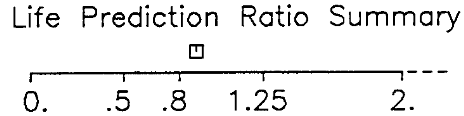




ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.91 (min)	0.135
9.	0.142
10.	0.238
13.	0.732
16.	1.54
20.	3.08
25.	5.64
30.	8.86
35.	12.8
40.	17.5
50.	29.9
60.	47.0
70.	68.4
80.	93.5
85.01 (max)	107.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.78 (min)	0.316
10.	0.359
13.	1.38
16.	3.46
20.	8.11
25.	17.0
30.	29.0
35.	43.7
40.	61.0
50.	103.
59.32 (max)	150.

RMS % Error 4.08



RMS % Error 14.83

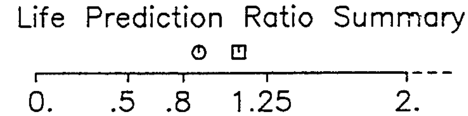


Figure 4.17.3.1.17

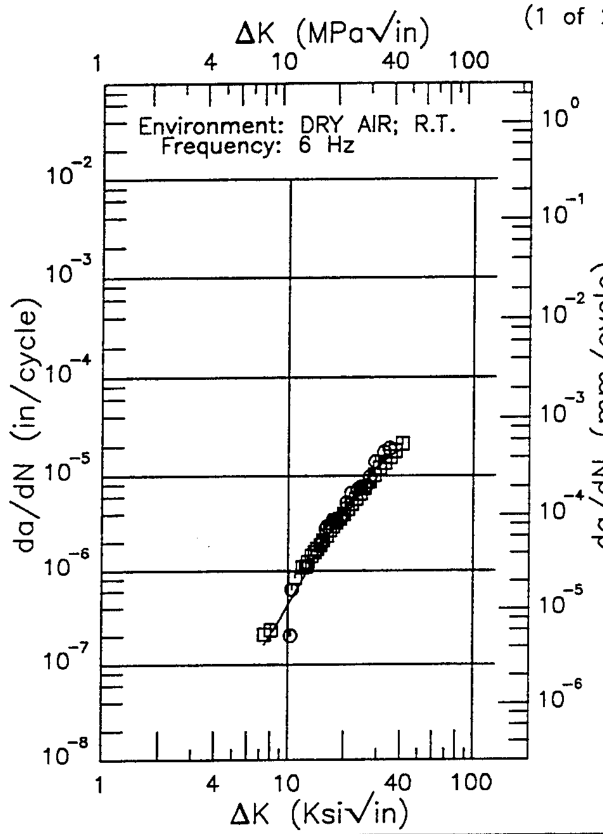
EF

PH13-8Mo

Condition/Ht: H1000
Form: 1 – 4 in. Forged Bar
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.3

Yield Strength: 201 – 215 ksi
Ult. Strength: 212 – 221 ksi
Specimen Thk: 0.5 – 0.993 in.
Specimen Width: 3.992 – 6 in.
Ref: GD009;85837

(1 of 2)



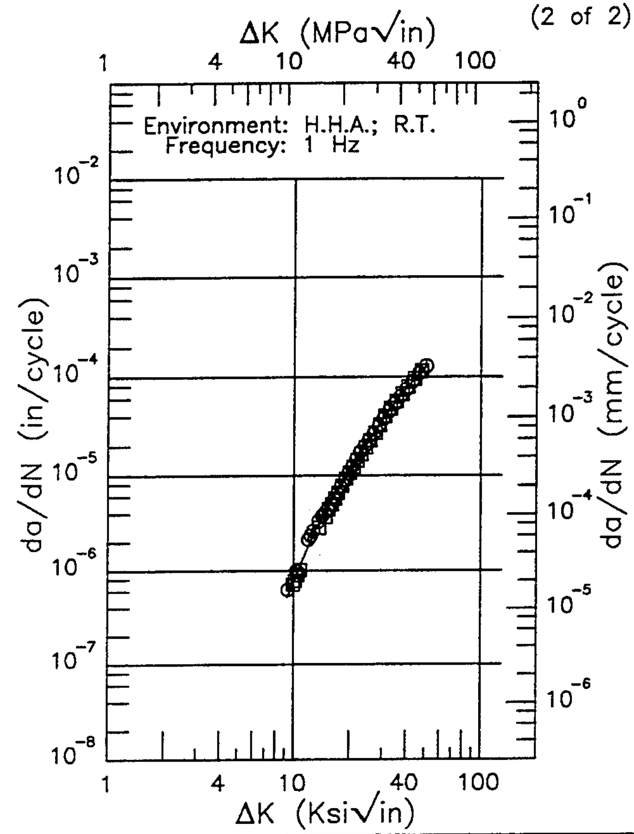
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.44 (min)	0.162
8.	0.205
9.	0.303
10.	0.434
13.	1.08
16.	2.20
20.	4.46
25.	8.24
30.	12.4
35.	16.0
40.	18.6
40.86 (max)	19.0

RMS % Error: 18.66

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.28 (min)	0.520
10.	0.796
13.	2.62
16.	5.38
20.	10.8
25.	21.7
30.	37.0
35.	55.0
40.	75.6
50.	124.
50.68 (max)	127.

RMS % Error: 6.20

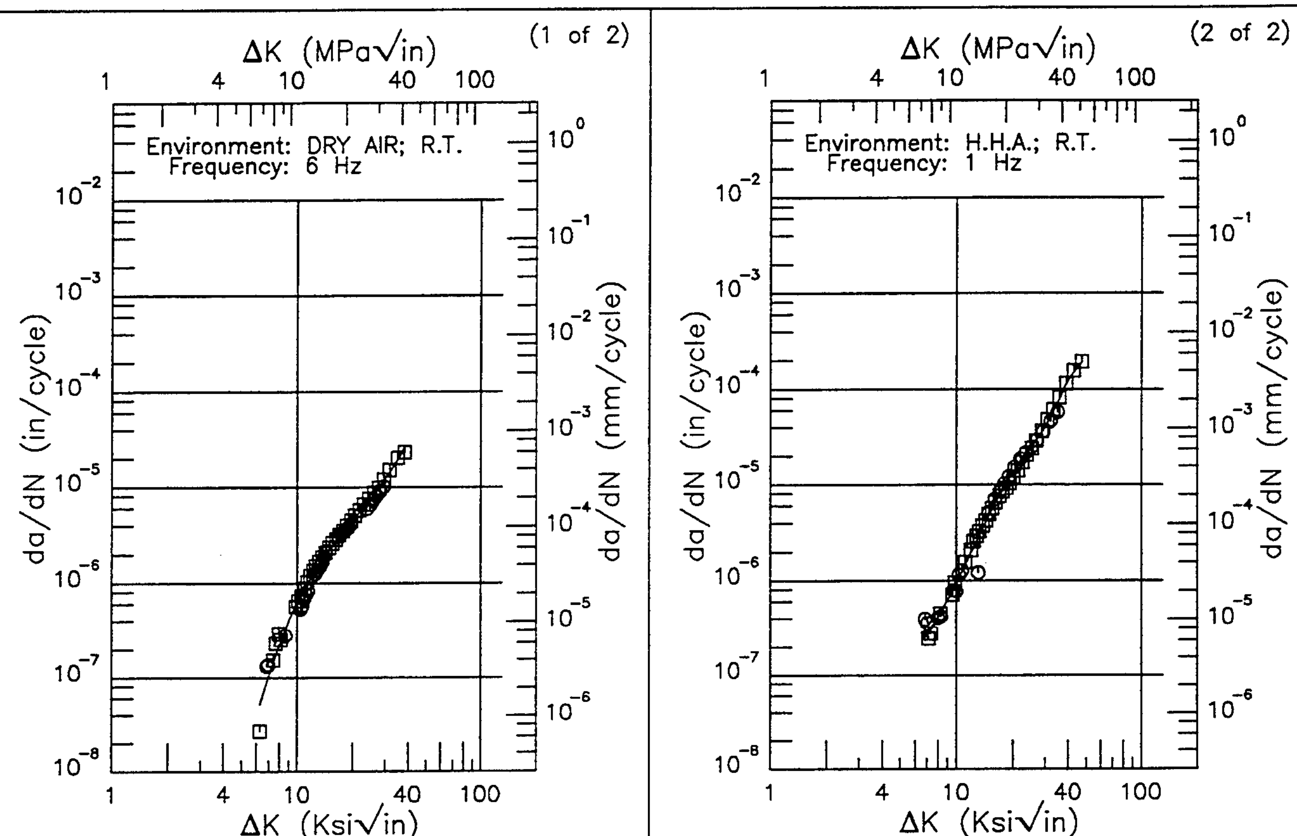
Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.17.3.1.18

Condition/Ht: H1000
Form: 1 - 4 in. Forged Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.5

Yield Strength: 201 - 215 ksi
Ult. Strength: 212 - 221 ksi
Specimen Thk: 0.501 - 0.99 in.
Specimen Width: 3.987 - 6 in.
Ref: GD009;88579



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.27 (min)	0.0519
7.	0.106
8.	0.226
9.	0.401
10.	0.627
13.	1.54
16.	2.68
20.	4.52
25.	7.58
30.	12.1
35.	19.4
37.95 (max)	25.6

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.78 (min)	0.251
7.	0.273
8.	0.410
9.	0.622
10.	0.934
13.	2.73
16.	6.22
20.	13.3
25.	24.1
30.	39.9
35.	71.0
40.	126.
47.33 (max)	190.

RMS % Error	Life Prediction Ratio Summary
14.80	0. .5 .8 1.25 2.
14.10	0. .5 .8 1.25 2.

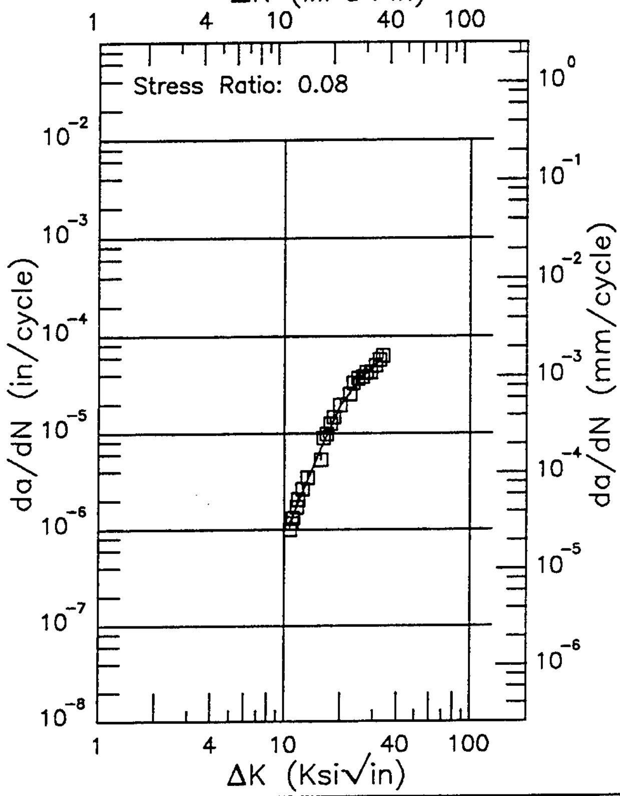
Figure 4.17.3.1.19

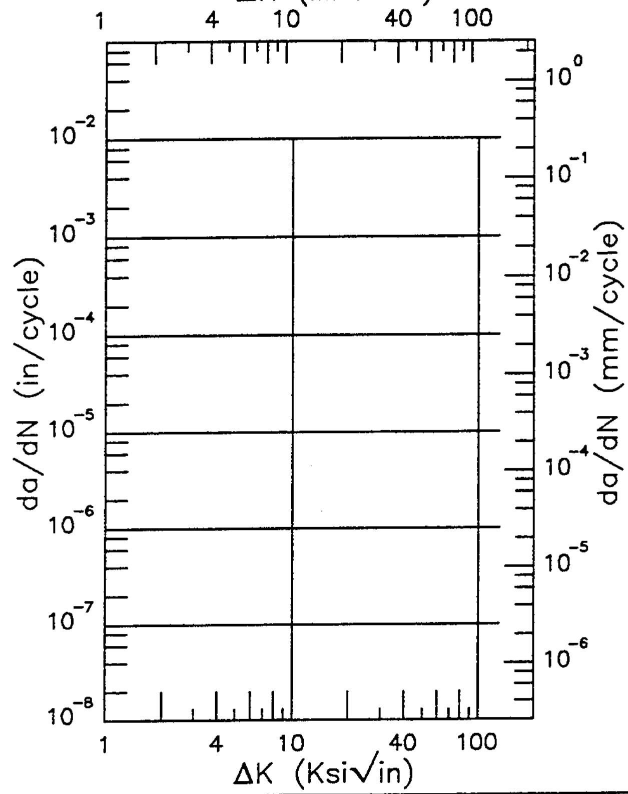
R PH13-8Mo

Condition/Ht: H1000
Form: 4 in. Forged Bar
Specimen Type: CT
Orientation: T-L
Frequency: 1 Hz
Environment: S.T.W.; RT

Yield Strength: 198 ksi
Ult. Strength: 206 ksi
Specimen Thk: 0.991 in.
Specimen Width: 6 in.
Ref: 85837

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.68 (min)	1.18
13.	2.83
16.	7.56
20.	19.2
25.	35.3
30.	48.6
33.64 (max)	60.2

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
9.33	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.20

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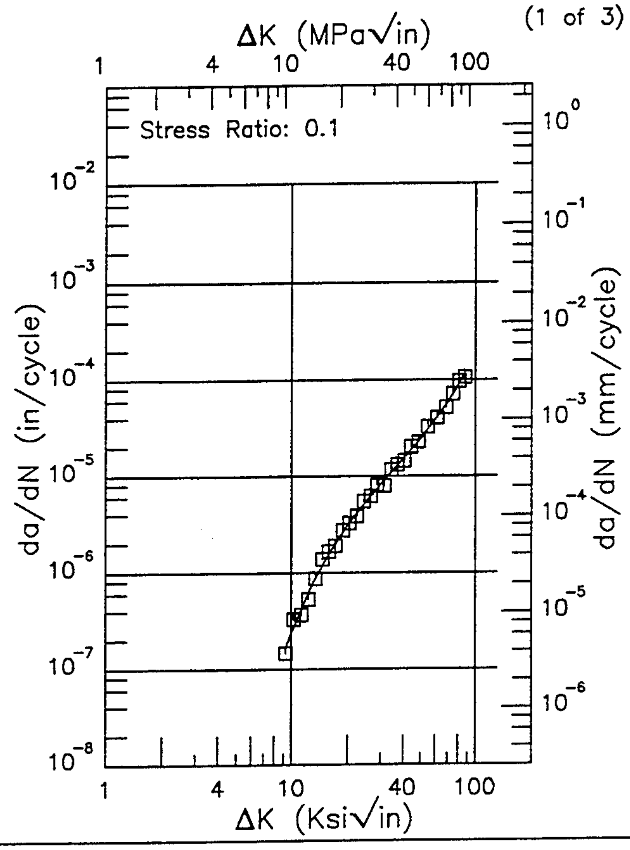
R

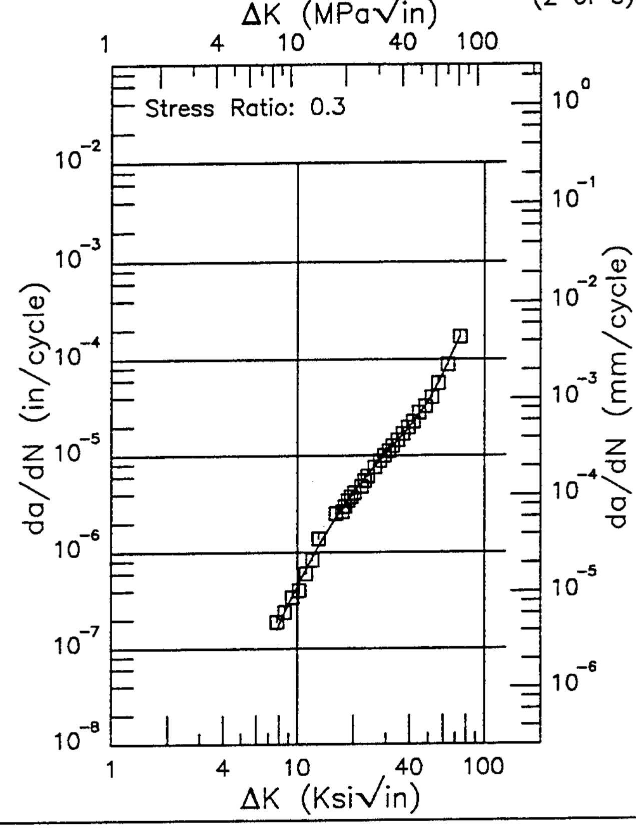
PH13–8Mo

Condition/Ht: H1000	
Form: 1 in. Forged Bar	Yield Strength: 216 ksi
Specimen Type: CT	Ult. Strength: 222.6 ksi
Orientation: T–L	Specimen Thk: 0.502 – 0.503 in.
Frequency: 6 Hz	Specimen Width: 3.991 – 3.993 in.
Environment: DRY AIR; RT	Ref: GD009

(1 of 3)



(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.25 (min)	0.161
10.	0.241
13.	0.768
16.	1.61
20.	3.12
25.	5.45
30.	8.18
35.	11.4
40.	15.0
50.	24.5
60.	38.0
70.	57.8
80.	86.6
86.80 (max)	114.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.78 (min)	0.158
8.	0.179
9.	0.295
10.	0.449
13.	1.15
16.	2.20
20.	4.07
25.	6.99
30.	10.5
35.	14.7
40.	20.0
50.	36.4
60.	69.9
70.	136.
73.72 (max)	170.

RMS % Error	Life Prediction Ratio Summary
8.47	0. .5 .8 1.25 2.

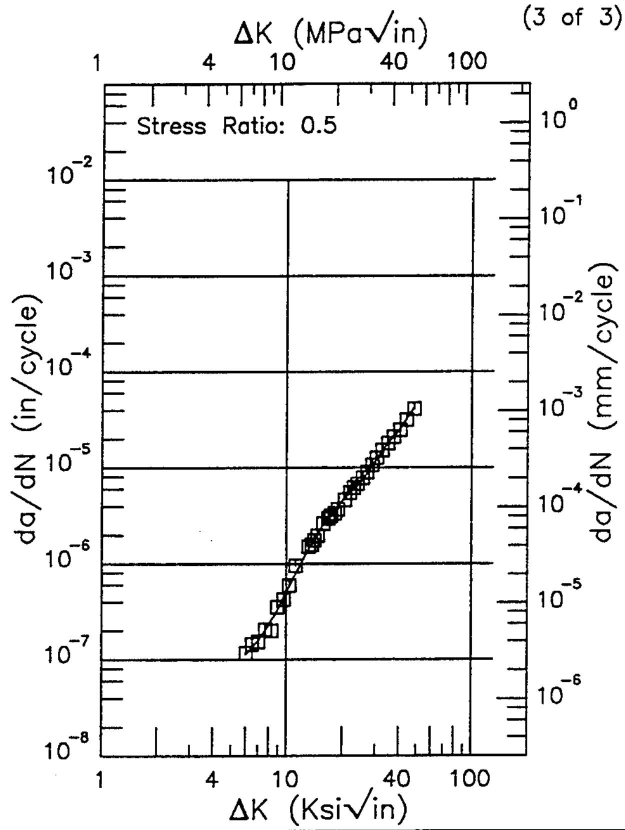
RMS % Error	Life Prediction Ratio Summary
6.99	0. .5 .8 1.25 2.

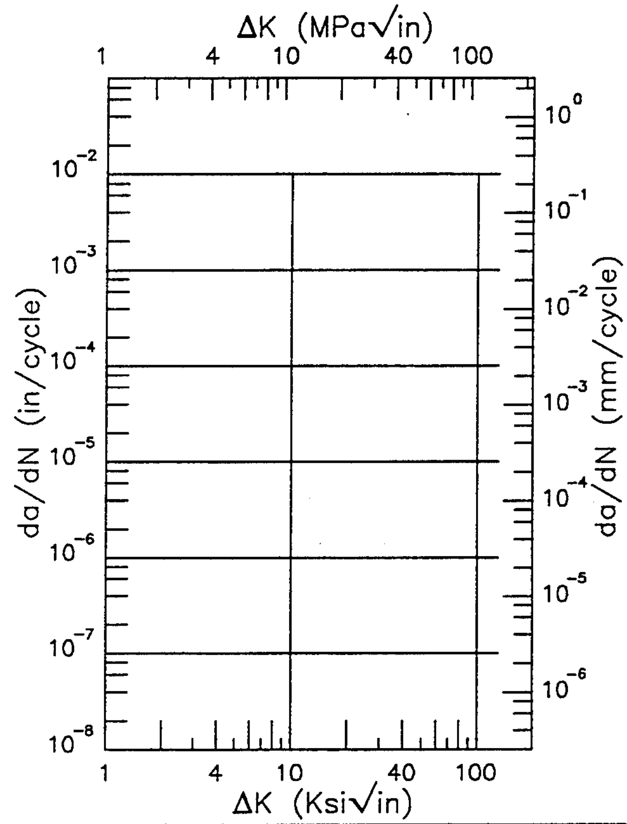
Figure 4.17.3.1.21

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: T-L
Frequency: 6 Hz
Environment: DRY AIR; RT

Yield Strength: 216 ksi
Ult. Strength: 222.6 ksi
Specimen Thk: 0.502 – 0.503 in.
Specimen Width: 3.991 – 3.993 in.
Ref: GD009

(3 of 3)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.00 (min)	0.114
7.	0.155
8.	0.229
9.	0.342
10.	0.506
13.	1.37
16.	2.71
20.	4.56
25.	7.19
30.	11.7
35.	18.2
40.	24.4
48.04 (max)	41.4

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
6.43	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.21 (Concluded)

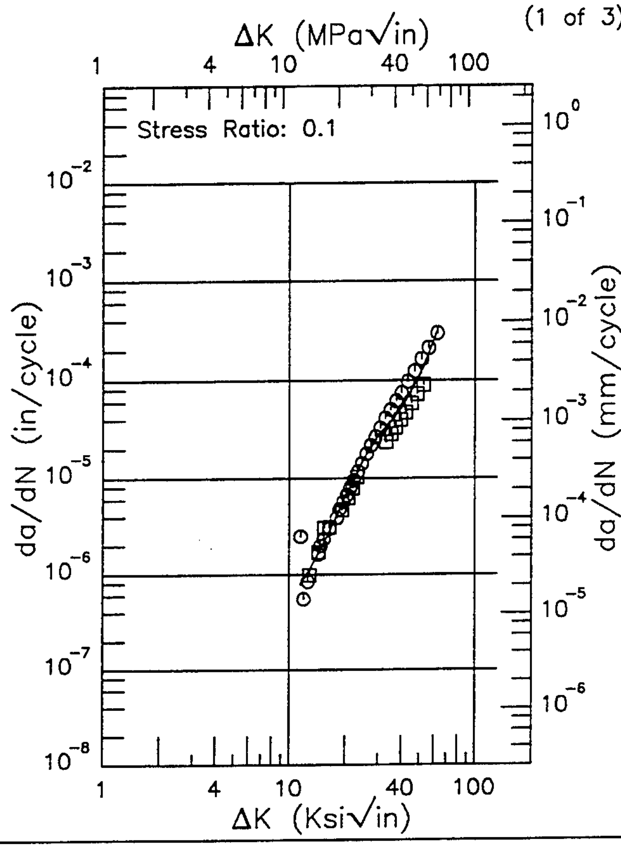
R

PH13-8Mo

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: T-L
Frequency: 1 Hz
Environment: H.H.A.; RT

Yield Strength: 216 ksi
Ult. Strength: 222.6 ksi
Specimen Thk: 0.499 – 0.504 in.
Specimen Width: 3.982 – 4.117 in.
Ref: GD009

(1 of 3)

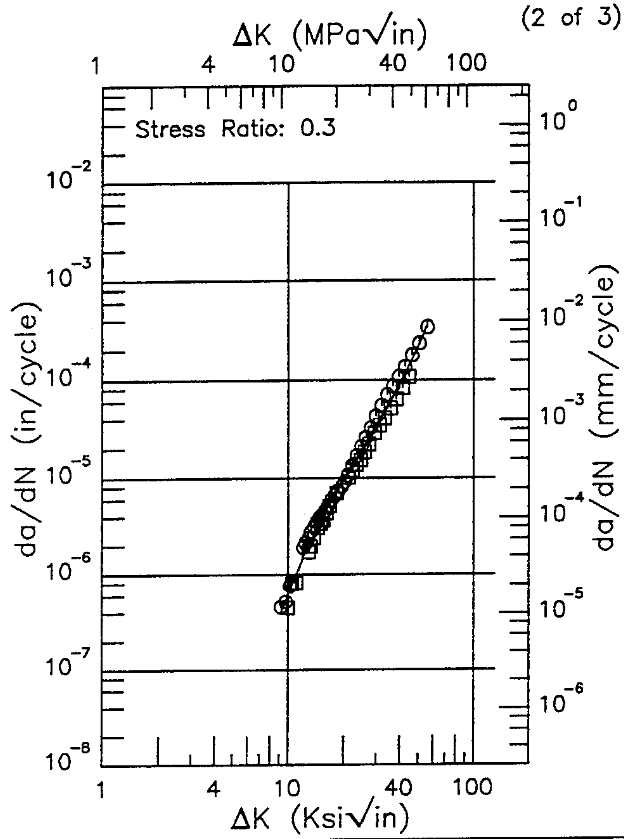


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.42 (min)	0.794
13.	1.16
16.	2.55
20.	6.49
25.	15.5
30.	27.0
35.	38.4
40.	52.4
50.	109.
60.	257.
62.14 (max)	308.

RMS % Error: 38.49

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.13 (min)	0.391
10.	0.627
13.	2.05
16.	4.52
20.	9.62
25.	19.5
30.	34.6
35.	57.2
40.	90.9
50.	215.
56.12 (max)	355.

RMS % Error: 15.75

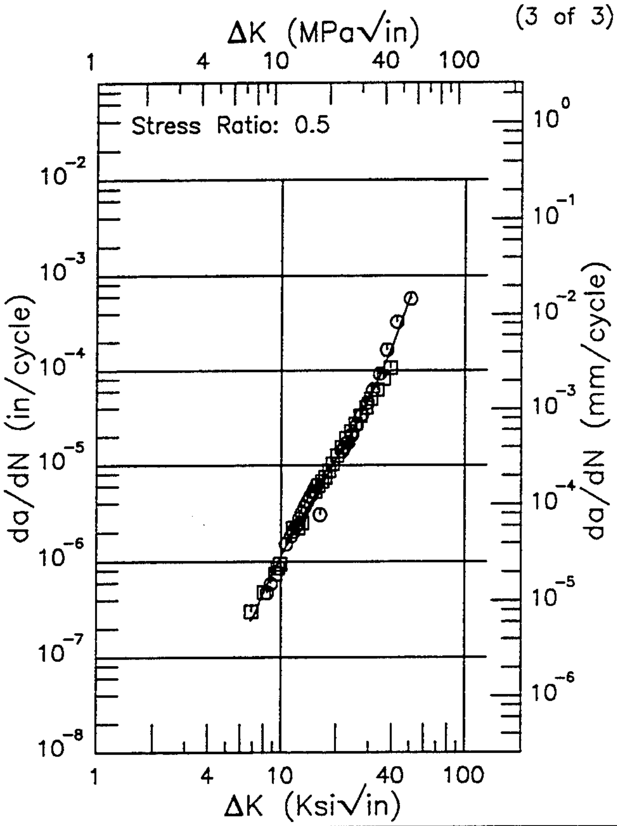
Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

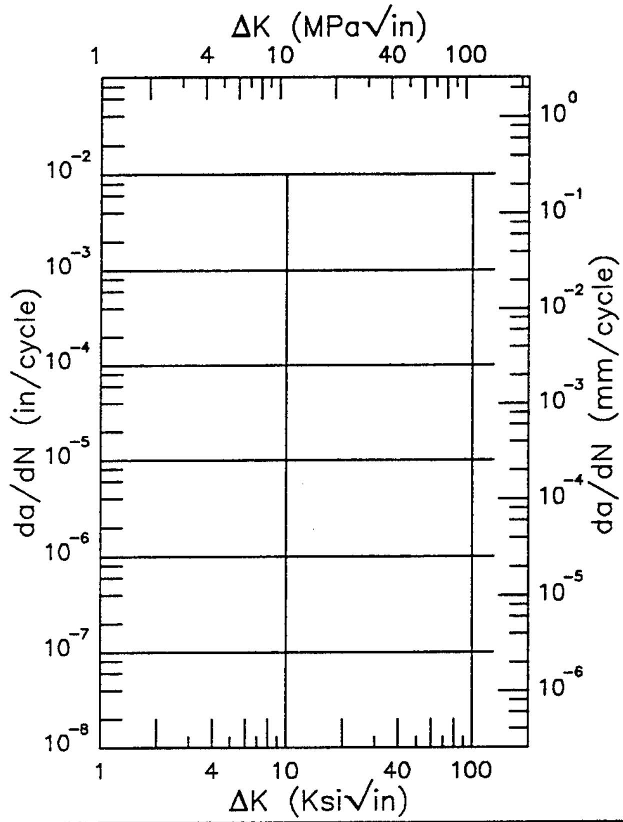
Figure 4.17.3.1.22

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: T-L
Frequency: 1 Hz
Environment: H.H.A.; RT

Yield Strength: 216 ksi
Ult. Strength: 222.6 ksi
Specimen Thk: 0.499 - 0.504 in.
Specimen Width: 3.982 - 4.117 in.
Ref: GD009

(3 of 3)



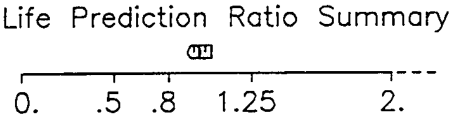


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
6.87 (min)	0.242
7.	0.264
8.	0.478
9.	0.770
10.	1.15
13.	2.85
16.	5.59
20.	11.5
25.	24.8
30.	49.4
35.	94.4
40.	176.
50.	579.
50.46 (max)	610.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error
14.72

Life Prediction Ratio Summary



RMS % Error

Life Prediction Ratio Summary

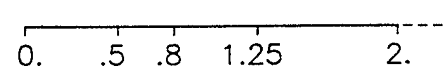


Figure 4.17.3.1.22 (Concluded)

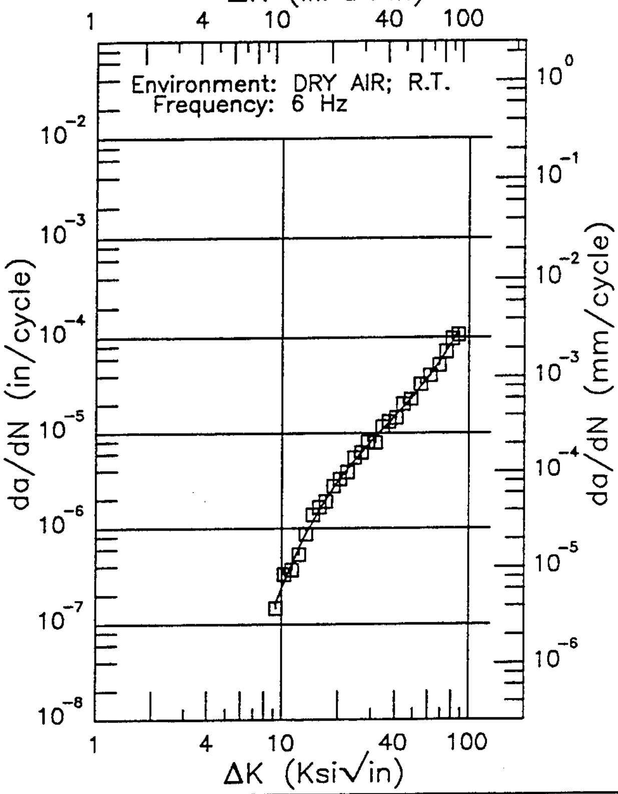
PH13-8Mo

EF

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.1

Yield Strength: 216 ksi
Ult. Strength: 222.6 ksi
Specimen Thk: 0.501 – 0.504 in.
Specimen Width: 3.99 – 4.117 in.
Ref: GD009

(1 of 2)



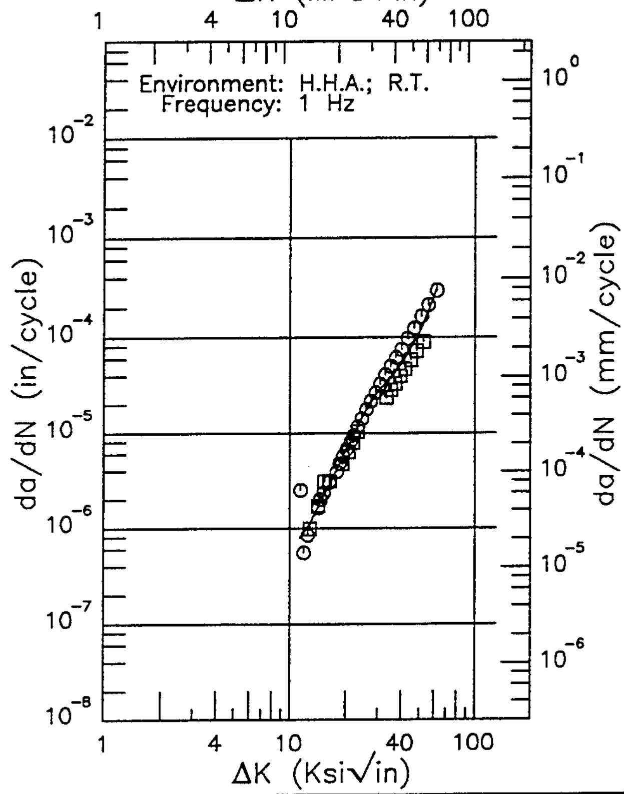
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.25 (min)	0.161
10.	0.241
13.	0.768
16.	1.61
20.	3.12
25.	5.45
30.	8.18
35.	11.4
40.	15.0
50.	24.5
60.	38.0
70.	57.8
80.	86.6
86.80 (max)	114.

RMS % Error 8.47

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.42 (min)	0.794
13.	1.16
16.	2.55
20.	6.49
25.	15.5
30.	27.0
35.	38.4
40.	52.4
50.	109.
60.	257.
62.14 (max)	308.

RMS % Error 38.49

Life Prediction Ratio Summary

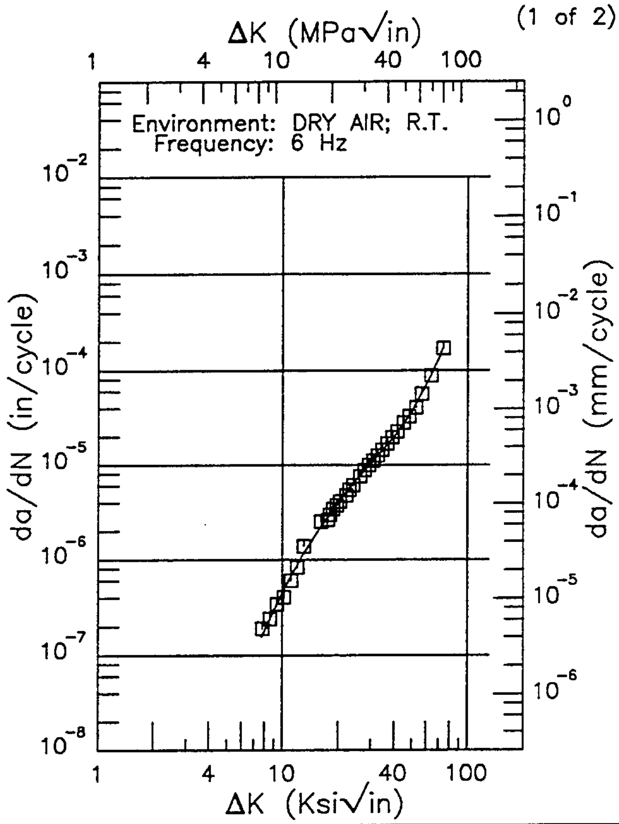
0. .5 .8 1.25 2.

Figure 4.17.3.1.23

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.3

Yield Strength: 216 ksi
Ult. Strength: 222.6 ksi
Specimen Thk: 0.501 – 0.502 in.
Specimen Width: 3.988 – 3.992 in.
Ref: GD009

(1 of 2)



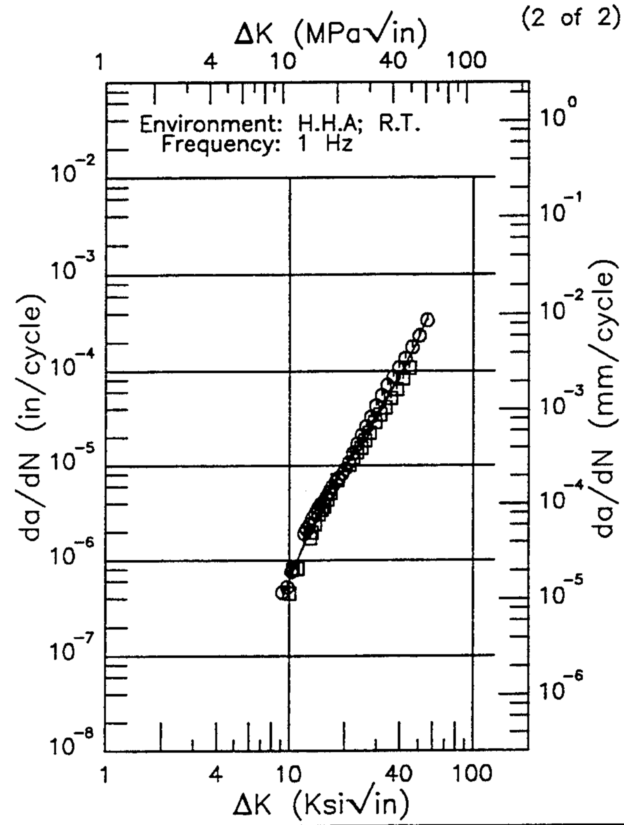
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.78 (min)	0.157
8.	0.178
9.	0.295
10.	0.450
13.	1.15
16.	2.19
20.	4.05
25.	6.99
30.	10.5
35.	14.7
40.	20.0
50.	36.6
60.	69.8
70.	134.
73.72 (max)	170.

RMS % Error 7.10

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.13 (min)	0.391
10.	0.627
13.	2.05
16.	4.52
20.	9.62
25.	19.5
30.	34.6
35.	57.2
40.	90.9
50.	215.
56.12 (max)	355.

RMS % Error 15.75

Life Prediction Ratio Summary

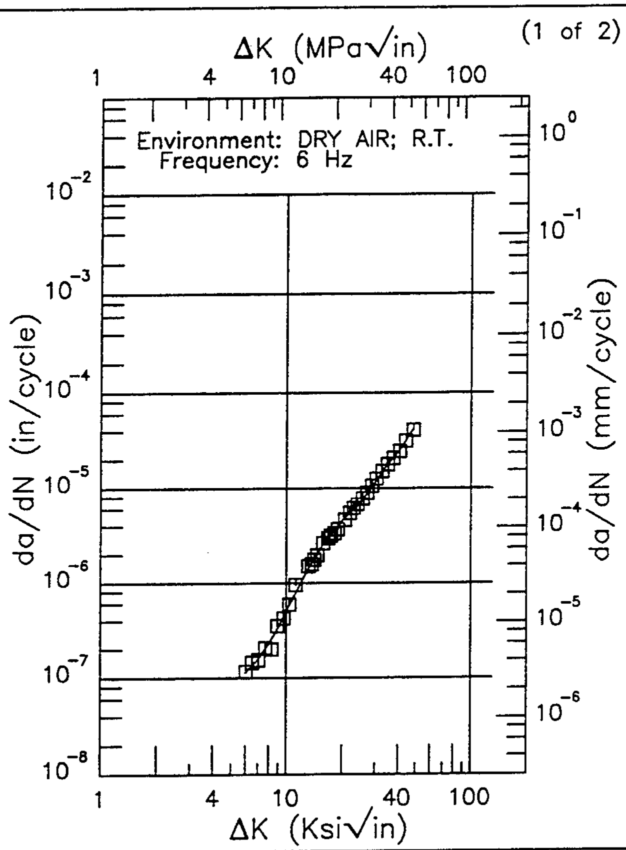
0. .5 .8 1.25 2.

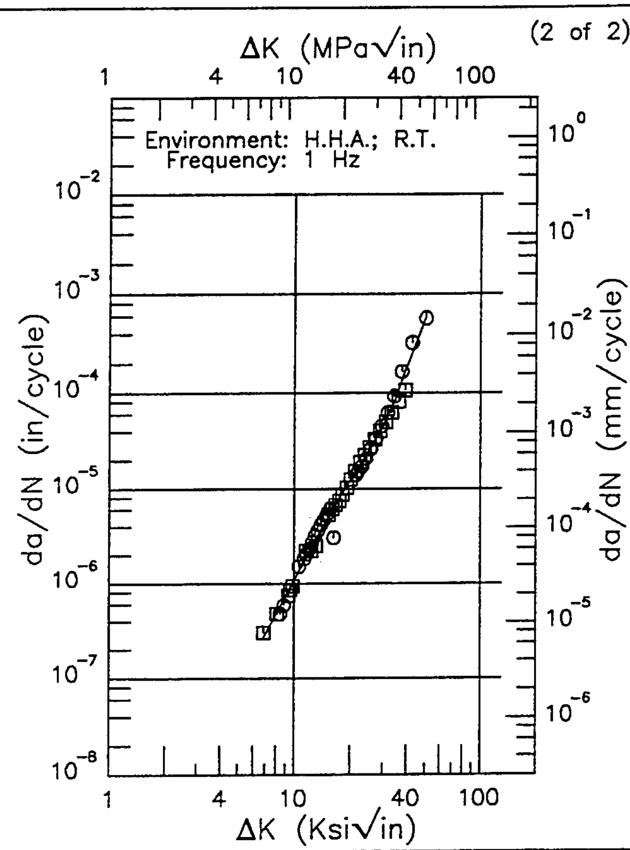
Figure 4.17.3.1.24

EF — PH13-8Mo

Condition/Ht: H1000
Form: 1 in. Forged Bar
Specimen Type: CT
Orientation: T-L
Stress Ratio: 0.5

Yield Strength: 216 ksi
Ult. Strength: 222.6 ksi
Specimen Thk: 0.499 - 0.503 in.
Specimen Width: 3.982 - 3.993 in.
Ref: GD009





(1 of 2)

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
6.00 (min)	0.114
7.	0.155
8.	0.229
9.	0.342
10.	0.506
13.	1.37
16.	2.71
20.	4.56
25.	7.19
30.	11.7
35.	18.2
40.	24.4
48.04 (max)	41.4

(2 of 2)

ΔK (Ksi√in)	da/dN (10^{-6} in/cycle)
6.87 (min)	0.271
7.	0.290
8.	0.470
9.	0.726
10.	1.08
13.	2.85
16.	5.98
20.	12.5
25.	24.1
30.	44.0
35.	87.4
40.	189.
50.	568.
50.46 (max)	583.

RMS % Error	Life Prediction Ratio Summary	RMS % Error	Life Prediction Ratio Summary
6.43	0. .5 .8 1.25 2.	13.84	0. .5 .8 1.25 2.

Figure 4.17.3.1.25

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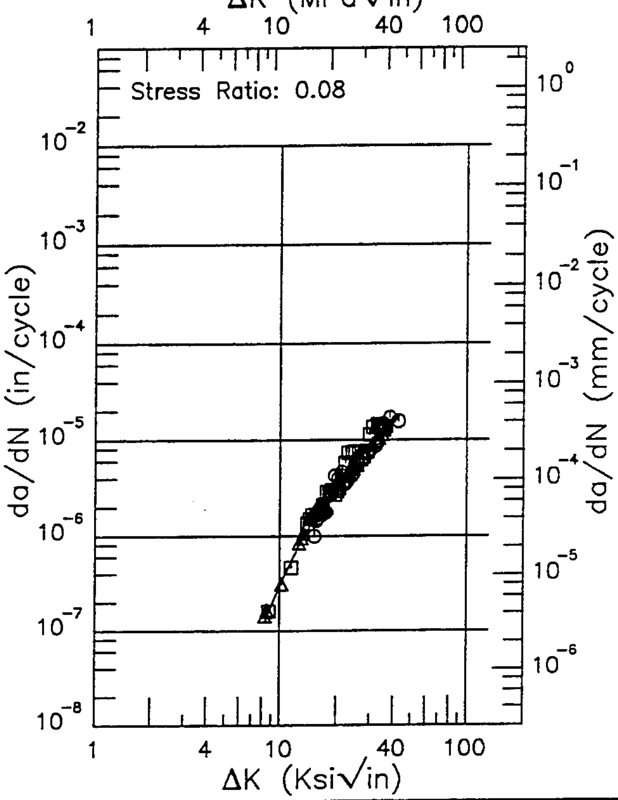
R

PH13-8Mo

Condition/Ht: H1000
Form: 1.5 in. Rolled Bar
Specimen Type: CT
Orientation: L-T
Frequency: 1 - 6 Hz
Environment: DRY AIR; RT

Yield Strength: 208 ksi
Ult. Strength: 216 ksi
Specimen Thk: 0.251 - 0.991 in.
Specimen Width: 7.39 - 7.4 in.
Ref: 85837;88579

(1 of 3)



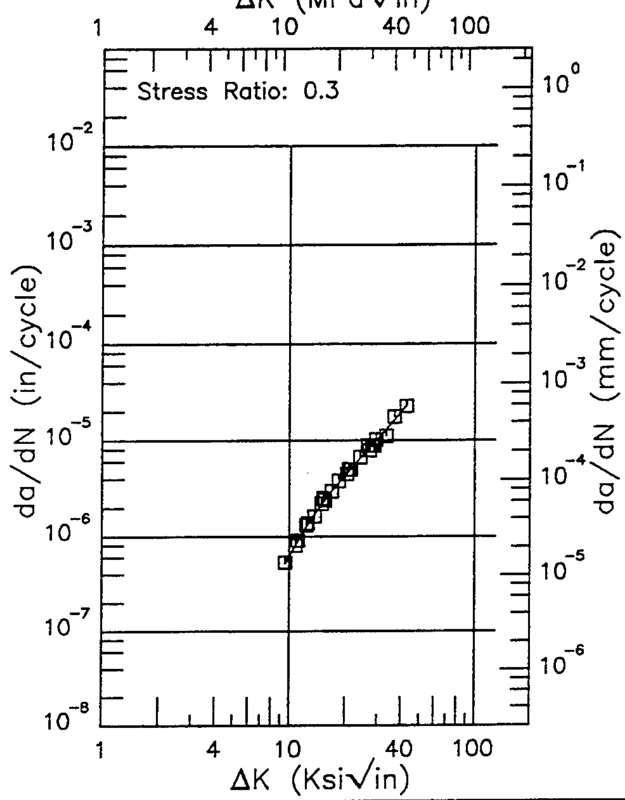
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.33 (min)	0.125
9.	0.184
10.	0.302
13.	0.879
16.	1.78
20.	3.41
25.	5.96
30.	8.94
35.	12.3
40.	16.0
42.46 (max)	18.0

RMS % Error 16.69

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.50 (min)	0.514
10.	0.624
13.	1.49
16.	2.61
20.	4.39
25.	7.05
30.	10.3
35.	14.4
40.	19.7
42.47 (max)	22.8

RMS % Error 5.42

Life Prediction Ratio Summary

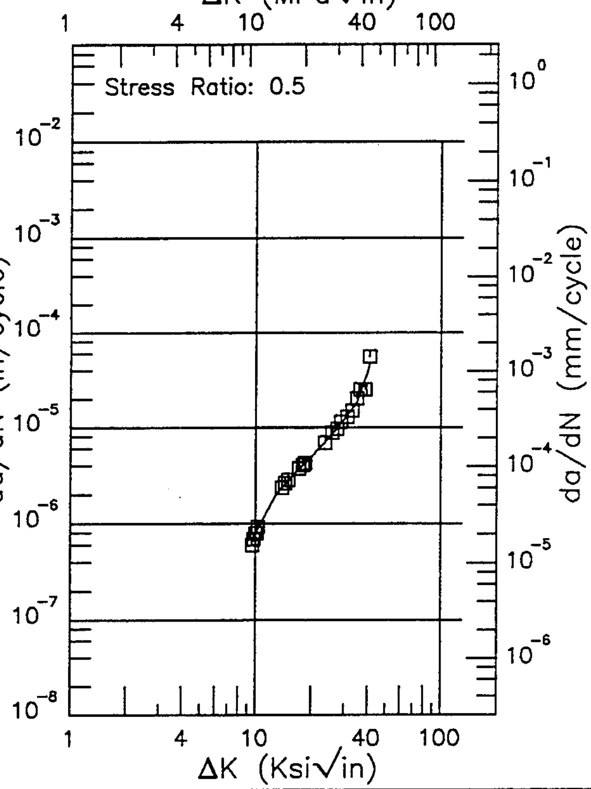
0. .5 .8 1.25 2.

Figure 4.17.3.1.26

Condition/Ht: H1000
Form: 1.5 in. Rolled Bar
Specimen Type: CT
Orientation: L-T
Frequency: 1 – 6 Hz
Environment: DRY AIR; RT

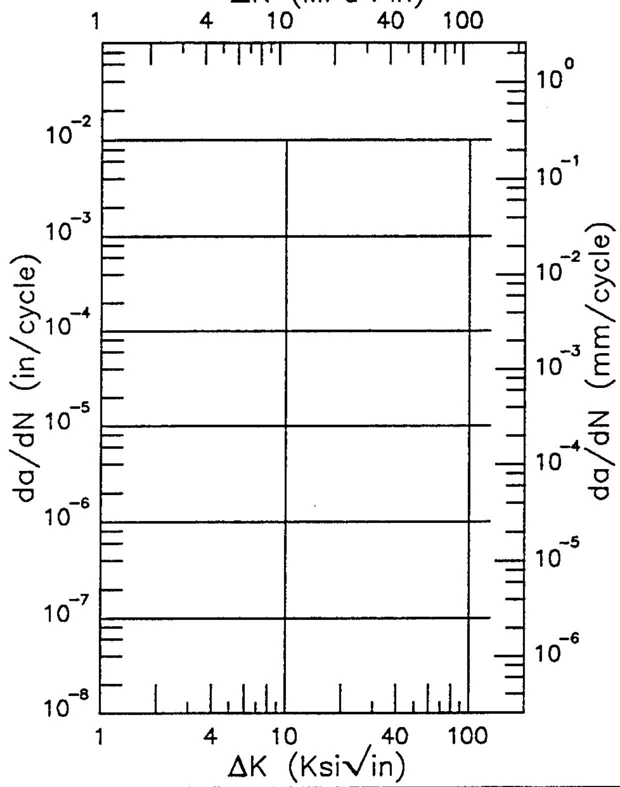
Yield Strength: 208 ksi
Ult. Strength: 216 ksi
Specimen Thk: 0.251 – 0.991 in.
Specimen Width: 7.39 – 7.4 in.
Ref: 85837;88579

(3 of 3)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
9.52 (min)	0.628
10.	0.796
13.	2.01
16.	3.22
20.	4.93
25.	7.96
30.	12.2
35.	18.6
40.	39.2
41.04 (max)	48.6

RMS % Error	Life Prediction Ratio Summary
6.68	0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.26 (Concluded)

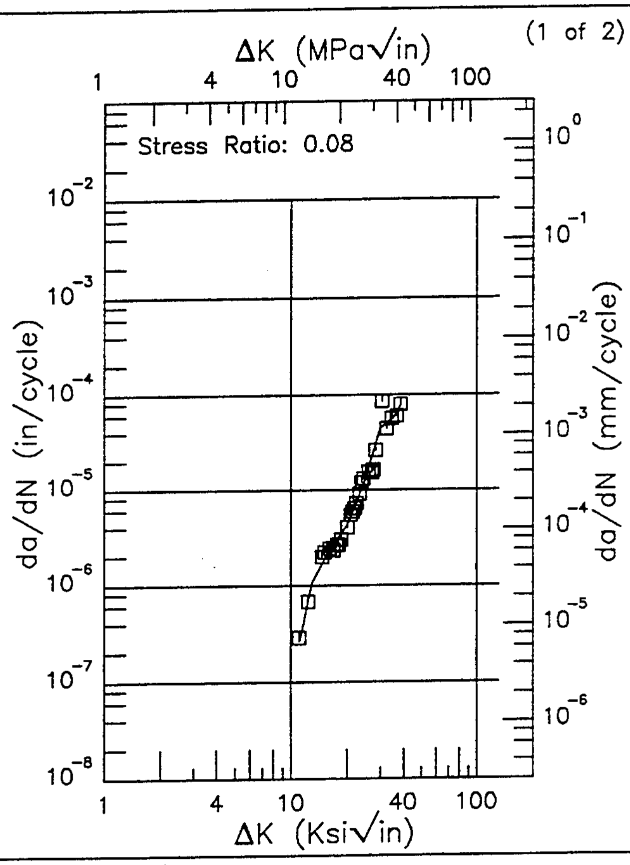
PH13-8Mo

R

Condition/Ht: H1000
Form: 1.5 in. Rolled Bar
Specimen Type: CT
Orientation: L-T
Frequency: 1 Hz
Environment: S.T.W.; RT

Yield Strength: 208 ksi
Ult. Strength: 216 ksi
Specimen Thk: 0.99 – 1.002 in.
Specimen Width: 7.39 – 7.4 in.
Ref: 85837;88579

(1 of 2)



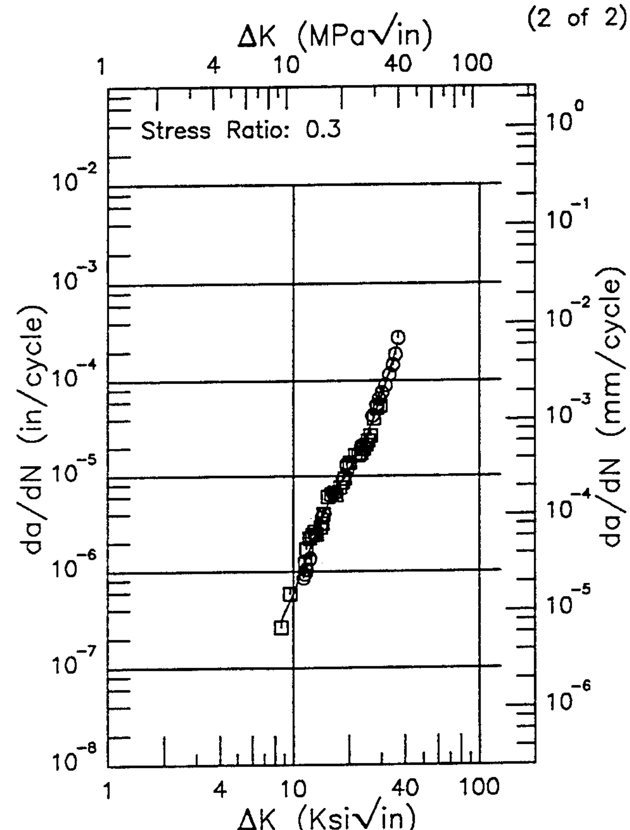
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.05 (min)	0.262
13.	1.06
16.	2.33
20.	4.20
25.	13.1
30.	45.3
35.	56.7
38.49 (max)	78.1

RMS % Error: 21.15

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.60 (min)	0.309
9.	0.366
10.	0.580
13.	2.26
16.	5.82
20.	11.9
25.	26.7
30.	68.8
35.	184.
36.46 (max)	243.

RMS % Error: 14.41

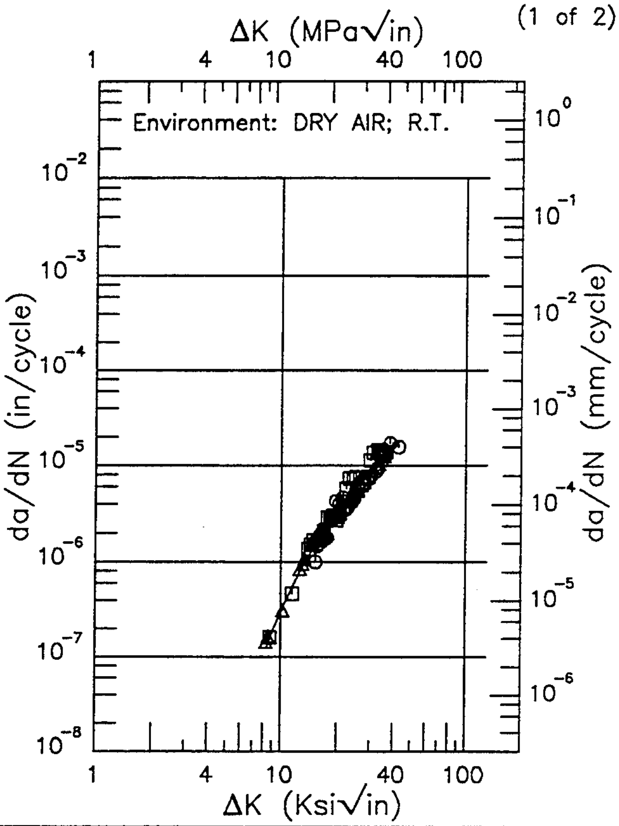
Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.17.3.1.27

Condition/Ht: H1000
Form: 1.5 in. Rolled Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Frequency: 1 - 6 Hz

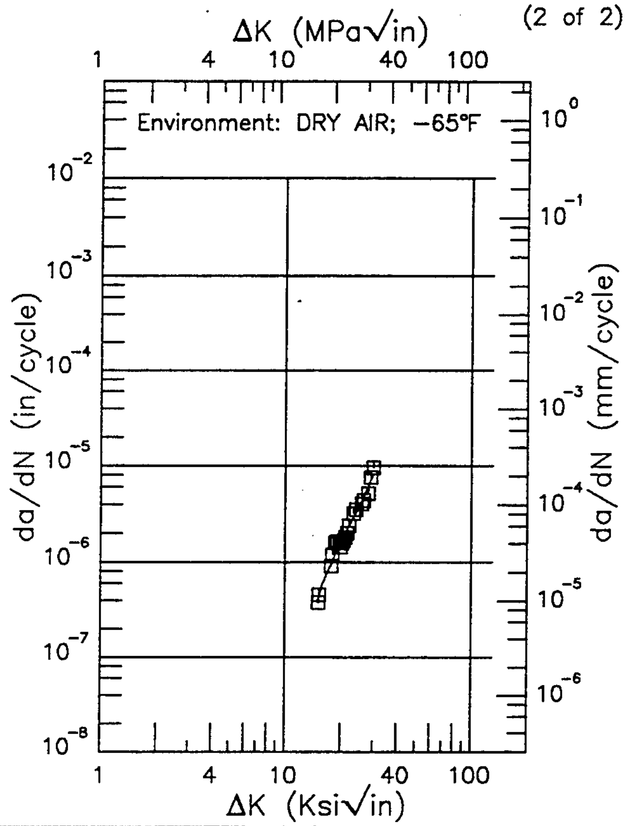
Yield Strength: 208 ksi
Ult. Strength: 216 ksi
Specimen Thk: 0.251 - 0.993 in.
Specimen Width: 7.39 - 7.4 in.
Ref: 85837;88579



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
8.33 (min)	0.125
9.	0.184
10.	0.302
13.	0.879
16.	1.78
20.	3.41
25.	5.96
30.	8.94
35.	12.3
40.	16.0
42.46 (max)	18.0

RMS % Error: 16.69

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
15.07 (min)	0.404
16.	0.594
20.	1.67
25.	3.68
29.64 (max)	7.95

RMS % Error: 13.42

Life Prediction Ratio Summary: 0. .5 .8 1.25 2.

Figure 4.17.3.1.28

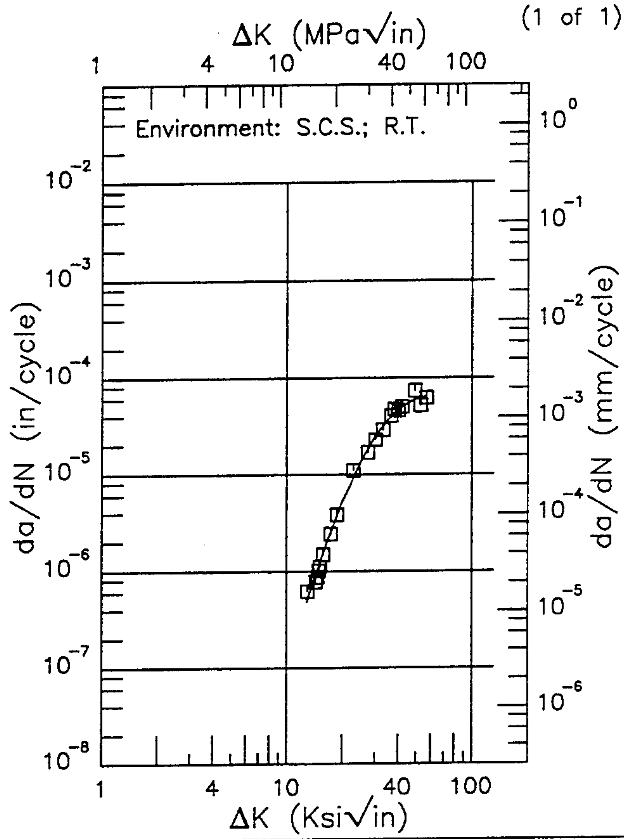
E

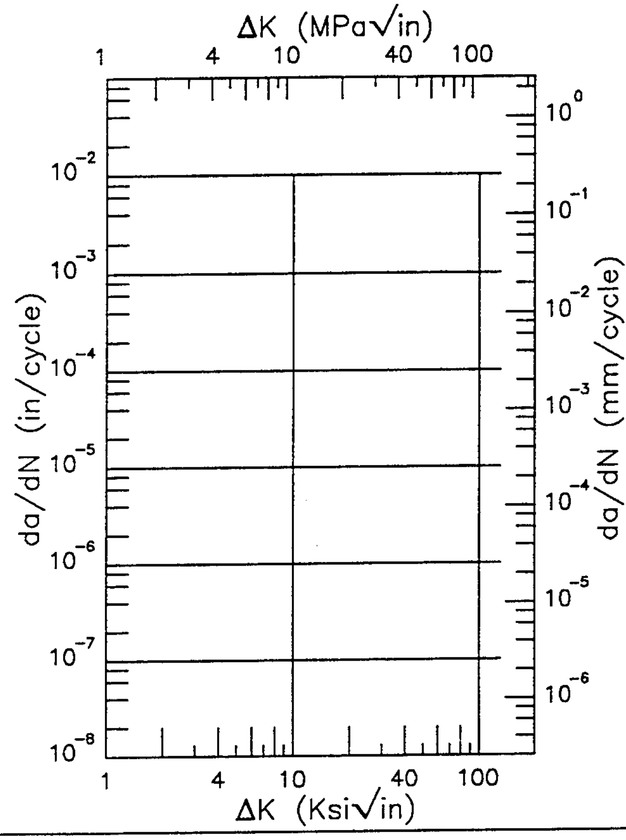
PH13–8Mo

Condition/Ht: H1000
Form: 1.5 in. Rolled Bar
Specimen Type: CT
Orientation: L–T
Stress Ratio: 0.08
Frequency: 1 Hz

Yield Strength: 208 ksi
Ult. Strength: 216 ksi
Specimen Thk: 0.99 in.
Specimen Width: 7.4 in.
Ref: 88579

(1 of 1)





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
12.88 (min)	0.488
13.	0.517
16.	1.72
20.	5.26
25.	13.2
30.	24.2
35.	36.1
40.	46.9
50.	60.9
56.24 (max)	63.7

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
11.99	0. .5 .8 1.25 2.

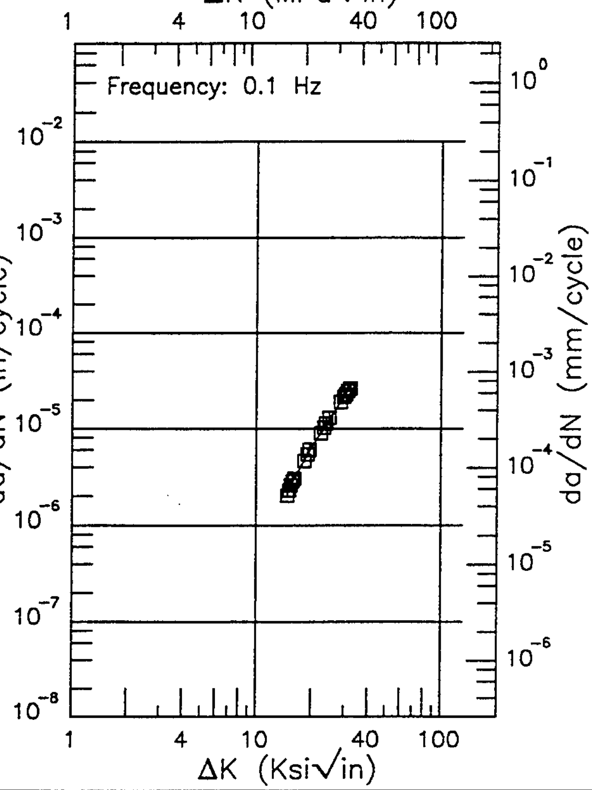
RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.29

Condition/Ht: H1000
Form: 1.5 in. Rolled Bar
Specimen Type: CT
Orientation: L-T
Stress Ratio: 0.08
Environment: S.T.W.; RT

Yield Strength: 208 ksi
Ult. Strength: 216 ksi
Specimen Thk: 0.99 – 1.002 in.
Specimen Width: 7.4 in.
Ref: 88579;85837

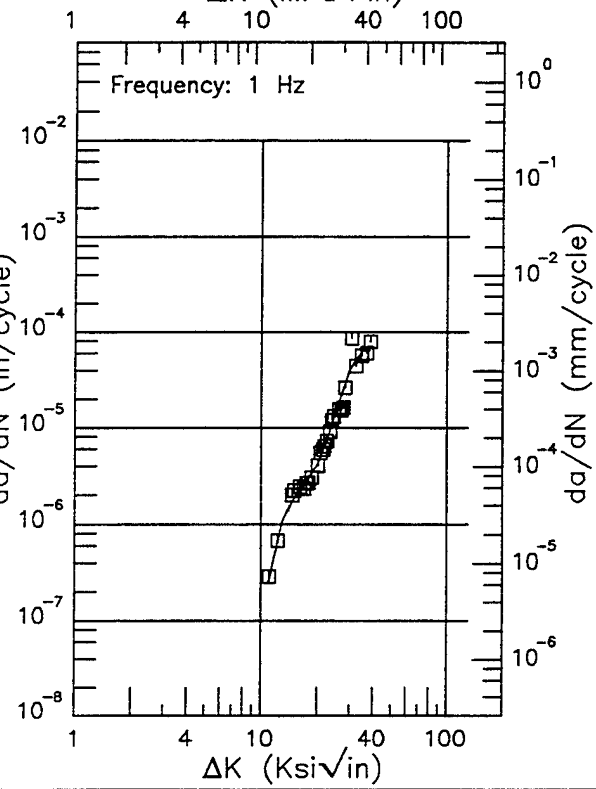
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
14.76 (min)	2.15
16.	2.95
20.	6.44
25.	12.9
30.	22.1
31.99 (max)	26.7

RMS % Error	Life Prediction Ratio Summary
2.62	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.05 (min)	0.256
13.	1.08
16.	2.30
20.	4.08
25.	14.1
30.	40.4
35.	64.6
38.49 (max)	64.7

RMS % Error	Life Prediction Ratio Summary
23.86	0. .5 .8 1.25 2.

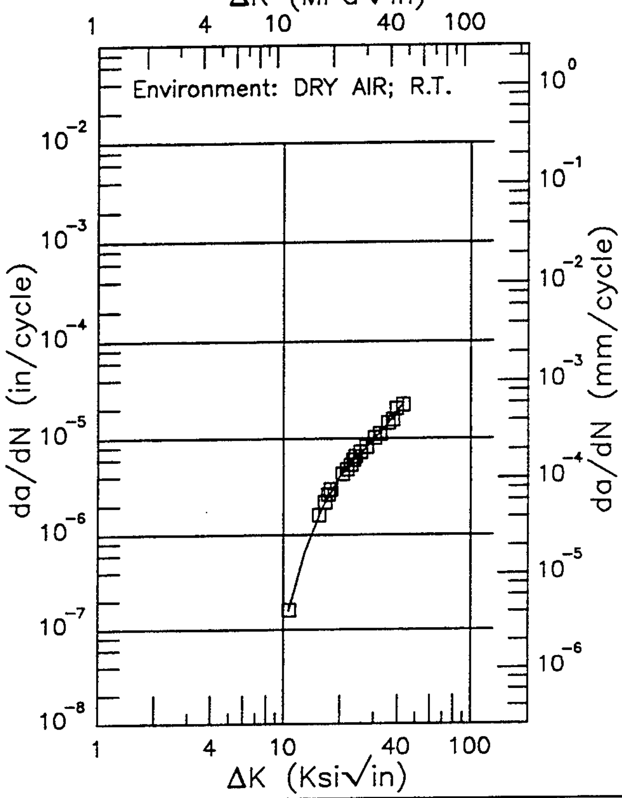
Figure 4.17.3.1.30

E

PH13-8Mo

Condition/Ht: H1000	Yield Strength: 210 – 215 ksi
Form: 1.5 in. Rolled Bar	Ult. Strength: 219 ksi
Specimen Type: CT	Specimen Thk: 0.989 – 0.99 in.
Orientation: T-L	Specimen Width: 7.4 in.
Stress Ratio: 0.08	Ref: 88579;85837
Frequency: 6 Hz	

(1 of 2)



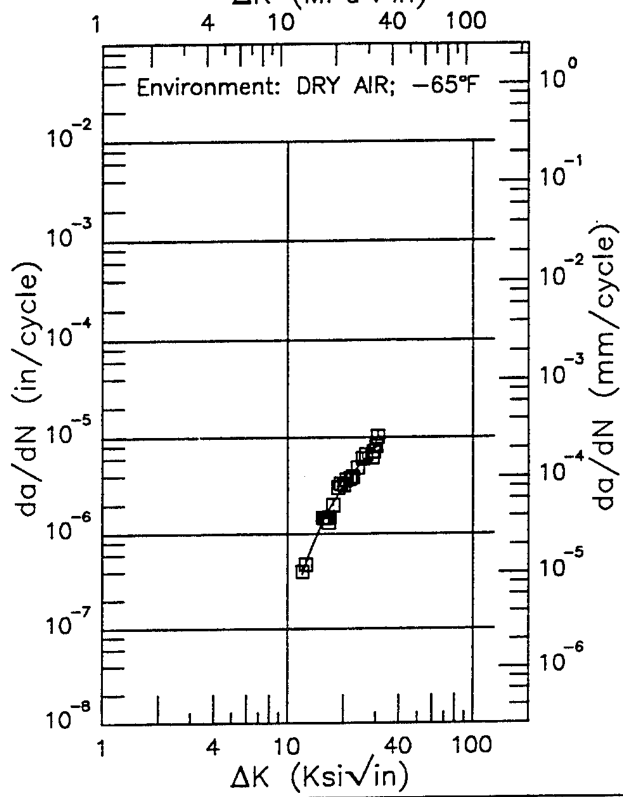
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.66 (min)	0.158
13.	0.650
16.	1.87
20.	4.05
25.	6.76
30.	9.63
35.	13.6
40.	19.0
42.91 (max)	22.6

RMS % Error 4.03

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
11.98 (min)	0.377
13.	0.598
16.	1.53
20.	3.15
25.	5.39
30.	7.89
30.75 (max)	8.30

RMS % Error 11.21

Life Prediction Ratio Summary

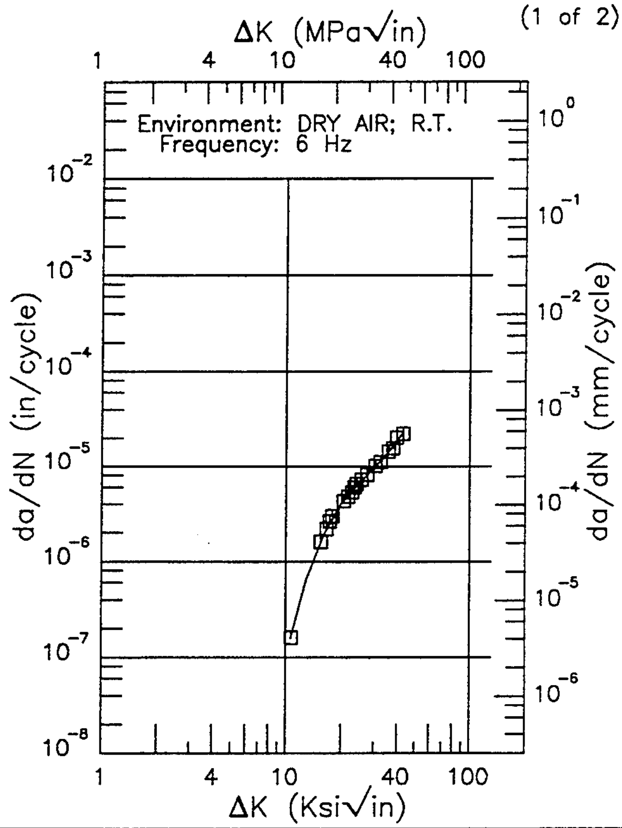
0. .5 .8 1.25 2.

Figure 4.17.3.1.31

Condition/Ht: H1000
Form: 1.5 in. Rolled Bar
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.08

Yield Strength: 210 – 215 ksi
Ult. Strength: 219 ksi
Specimen Thk: 0.99 – 0.993 in.
Specimen Width: 7.4 in.
Ref: 88579

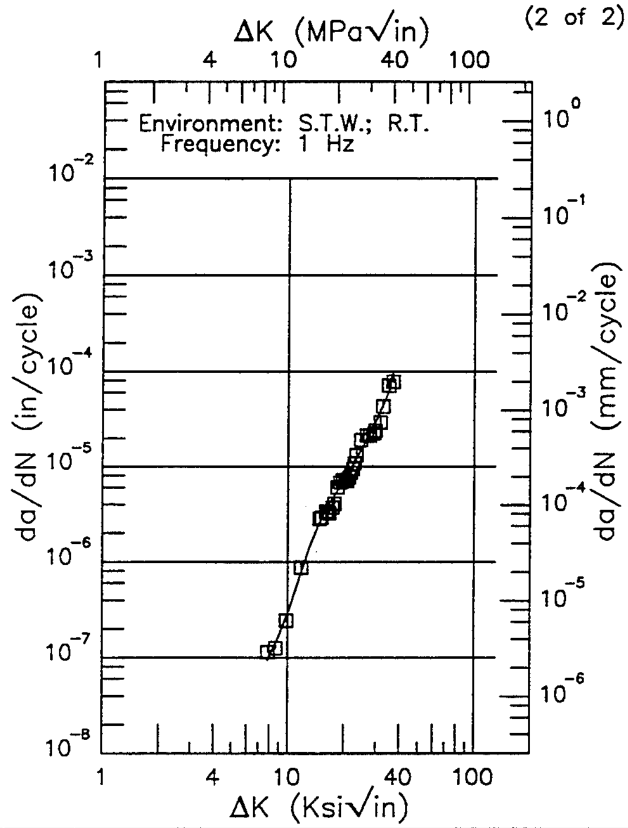
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
10.66 (min)	0.158
13.	0.650
16.	1.87
20.	4.05
25.	6.76
30.	9.63
35.	13.6
40.	19.0
42.91 (max)	22.6

RMS % Error	Life Prediction Ratio Summary
4.03	0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
7.82 (min)	0.0948
8.	0.102
9.	0.169
10.	0.297
13.	1.37
16.	3.58
20.	7.00
25.	15.3
30.	30.1
35.	60.7
36.71 (max)	96.4

RMS % Error	Life Prediction Ratio Summary
14.16	0. .5 .8 1.25 2.

Figure 4.17.3.1.32

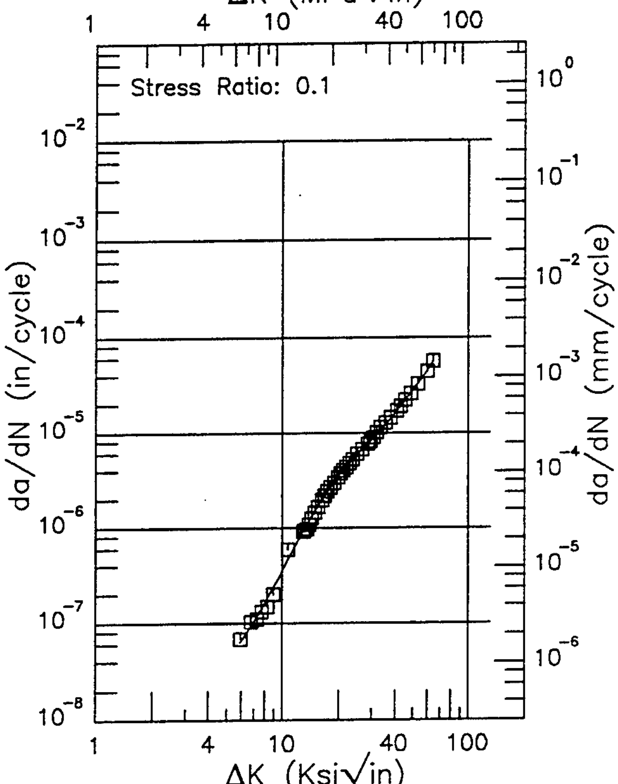
PH13-8Mo

R

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CT
Orientation: L-T
Frequency: 5 Hz
Environment: LAB AIR; RT

Yield Strength: 185.4 ksi
Ult. Strength:
Specimen Thk: 0.249 in.
Specimen Width: 2.006 – 2.008 in.
Ref: DA006

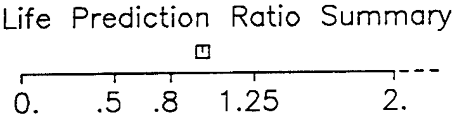
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.92 (min)	0.0628
6.	0.0650
7.	0.103
8.	0.161
9.	0.244
10.	0.358
13.	0.932
16.	1.89
20.	3.64
25.	6.01
30.	8.59
35.	11.8
40.	16.2
50.	28.1
60.	45.1
64.16 (max)	56.8

RMS % Error 7.04

Life Prediction Ratio Summary



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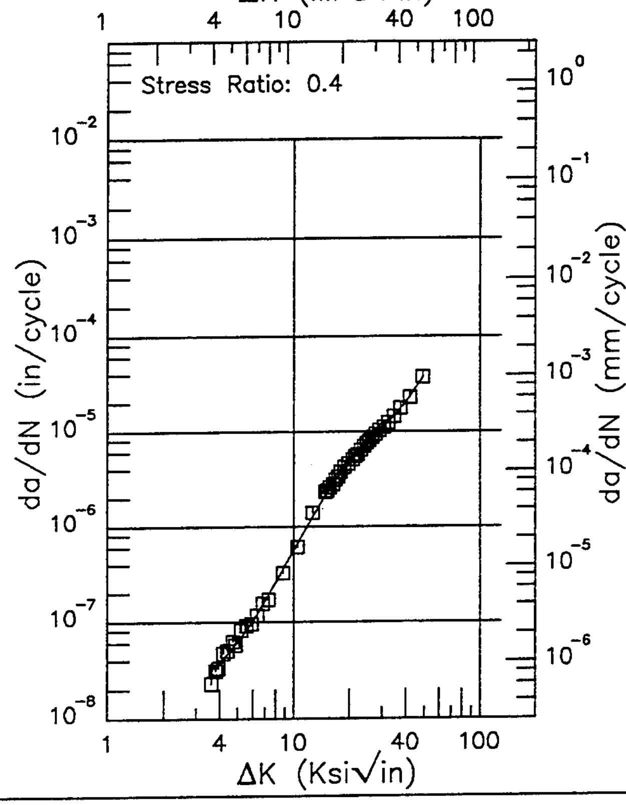


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.59 (min)	0.0317
4.	0.0375
5.	0.0612
6.	0.102
7.	0.165
8.	0.259
9.	0.390
10.	0.564
13.	1.39
16.	2.66
20.	4.82
25.	7.74
30.	11.0
35.	15.0
40.	20.2
49.30 (max)	36.9

RMS % Error 8.09

Life Prediction Ratio Summary

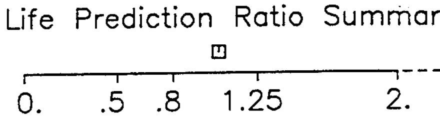
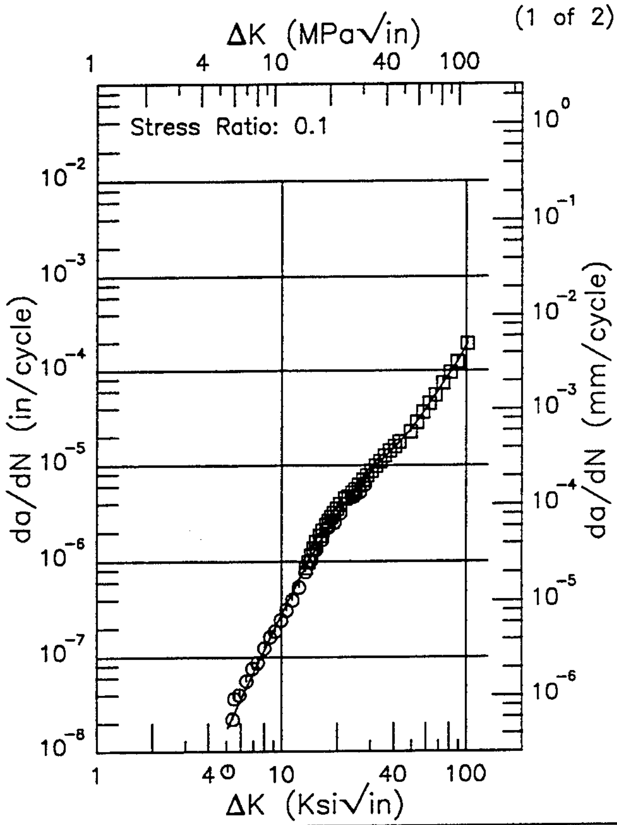


Figure 4.17.3.1.33

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CT
Orientation: L-T
Frequency: 20 Hz
Environment: LAB AIR; RT

Yield Strength: 196.5 ksi
Ult. Strength:
Specimen Thk: 0.249 - 0.25 in.
Specimen Width: 1.996 - 2 in.
Ref: DA007

(1 of 2)



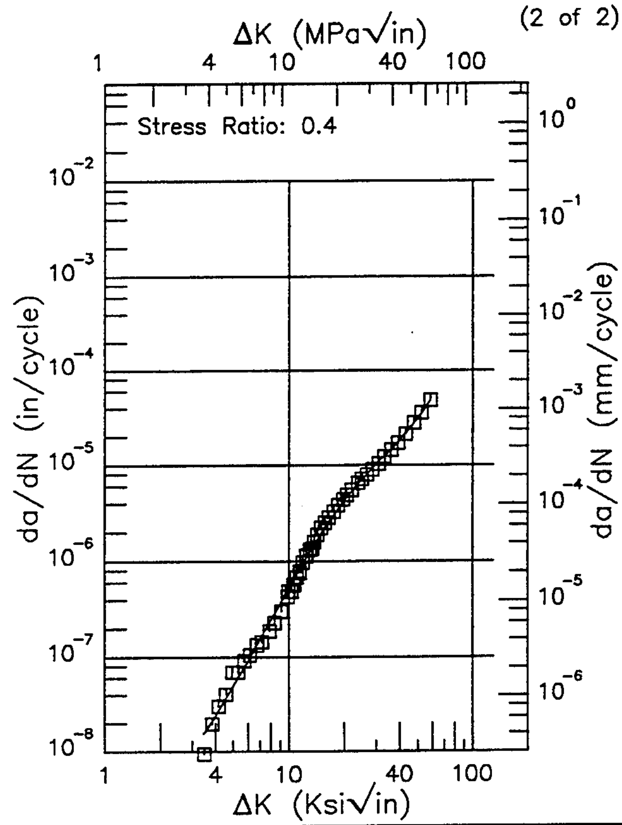
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.08 (min)	0.0180
6.	0.0360
7.	0.0682
8.	0.118
9.	0.188
10.	0.284
16.	1.55
20.	3.11
30.	8.64
40.	15.1
60.	39.0
80.	90.7
100.	184.
100.97 (max)	191.

RMS % Error: 14.16

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.46 (min)	0.0155
3.5	0.0160
4.	0.0240
5.	0.0492
6.	0.0910
7.	0.155
8.	0.246
9.	0.369
10.	0.529
16.	2.35
20.	4.28
30.	10.3
40.	18.3
58.45 (max)	48.8

RMS % Error: 13.07

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.17.3.1.34

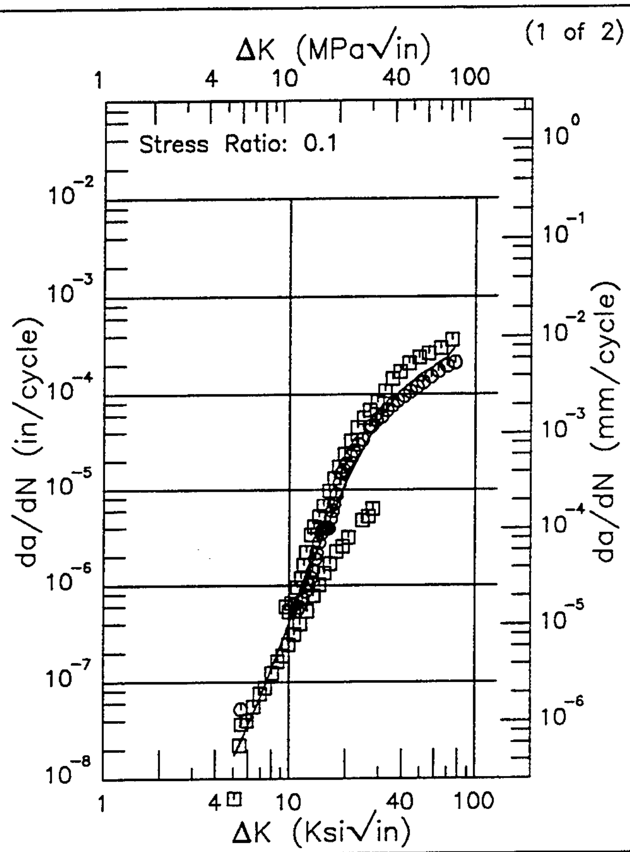
R

PH13–8Mo

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CT
Orientation: L–T
Frequency: 1 Hz
Environment: DIST WATER; RT

Yield Strength: 185.4 – 196.5 ksi
Ult. Strength:
Specimen Thk: 0.245 – 0.249 in.
Specimen Width: 1.996 – 2.008 in.
Ref: DA007;DA006

(1 of 2)



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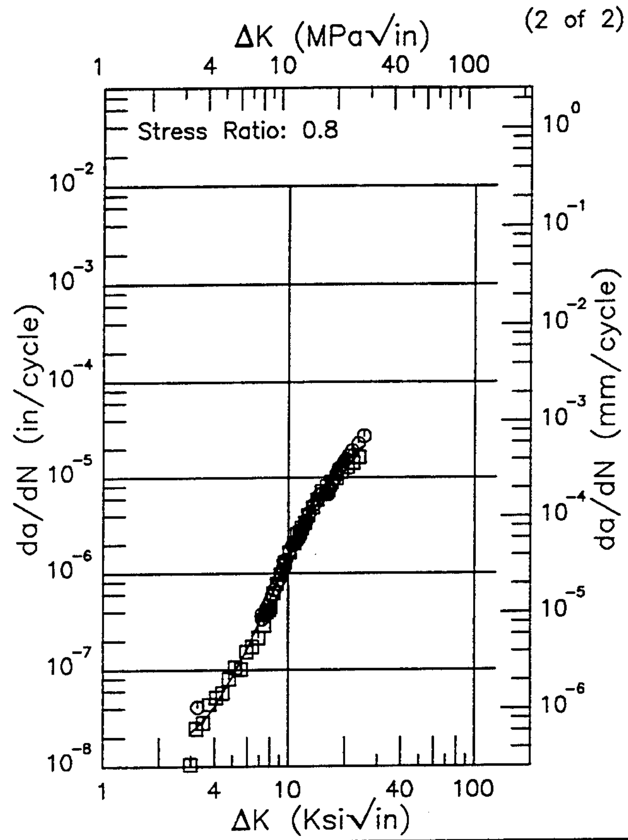


ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.08 (min)	0.0177
6.	0.0356
7.	0.0718
8.	0.136
9.	0.244
10.	0.413
13.	1.54
16.	4.24
20.	11.7
25.	28.5
30.	52.8
35.	81.6
40.	111.
50.	159.
60.	196.
70.	238.
77.04 (max)	301.

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
2.95 (min)	0.0218
3.	0.0224
4.	0.0298
4.	0.0417
5.	0.0846
6.	0.167
7.	0.310
8.	0.541
9.	0.888
10.	1.38
13.	3.88
16.	7.91
20.	14.5
25.	21.2
25.19 (max)	21.3

RMS % Error	Life Prediction Ratio Summary
56.90	0. .5 .8 1.25 2.

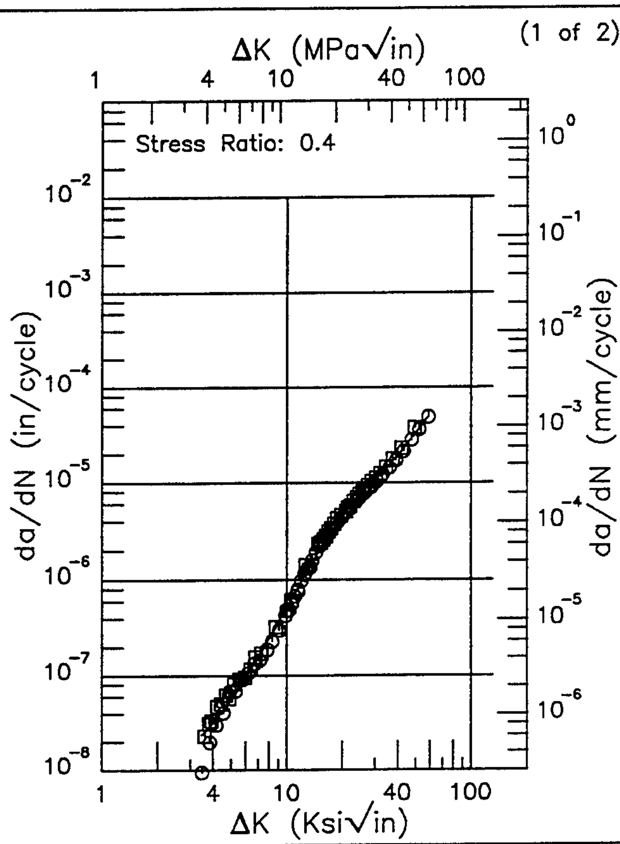
RMS % Error	Life Prediction Ratio Summary
14.89	0. .5 .8 1.25 2.

Figure 4.17.3.1.35

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CT
Orientation: L-T
Frequency: 5 - 30 Hz
Environment: LAB AIR; RT

Yield Strength: 185.4 - 196.5 ksi
Ult. Strength:
Specimen Thk: 0.248 - 0.25 in.
Specimen Width: 1.998 - 2.008 in.
Ref: DA006;DA007

(1 of 2)



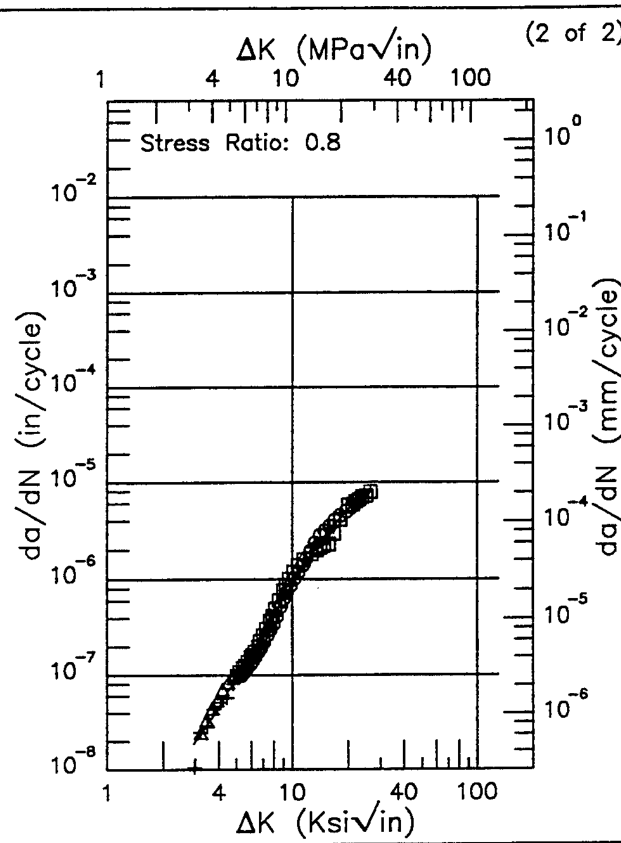
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.46 (min)	0.0234
3.5	0.0239
4.	0.0316
5.	0.0558
6.	0.0958
7.	0.157
8.	0.245
9.	0.367
10.	0.527
16.	2.45
20.	4.55
30.	10.8
40.	19.1
58.45 (max)	48.3

RMS % Error 13.38

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
2.95 (min)	0.0189
3.	0.0198
3.5	0.0307
4.	0.0460
5.	0.0936
6.	0.171
7.	0.284
8.	0.441
9.	0.644
10.	0.896
16.	3.28
20.	5.27
26.16 (max)	7.86

RMS % Error 15.28

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

Figure 4.17.3.1.36

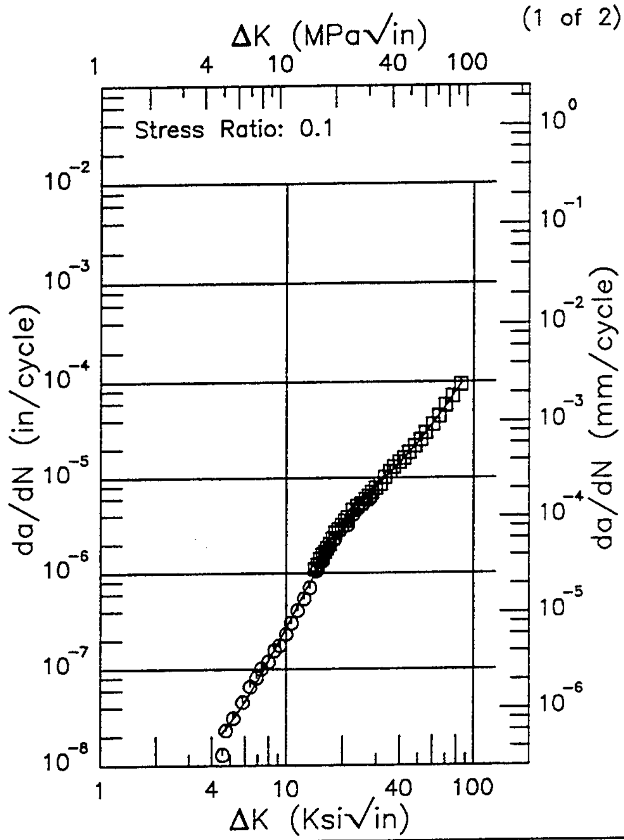
R

PH13-8Mo

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CT
Orientation: T-L
Frequency: 20 Hz
Environment: LAB AIR; RT

Yield Strength: 196.9 ksi
Ult. Strength:
Specimen Thk: 0.247 - 0.25 in.
Specimen Width: 1.996 - 1.998 in.
Ref: DA007

(1 of 2)



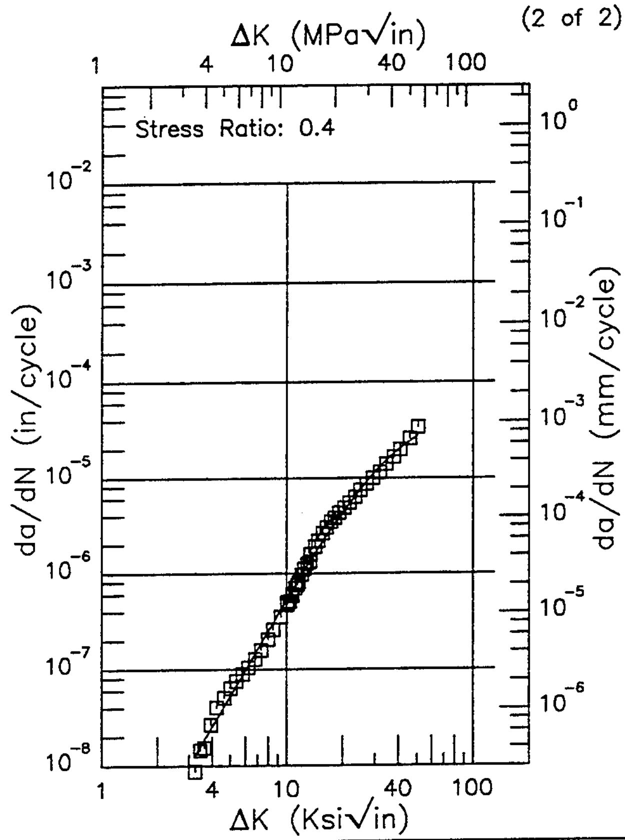
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.54 (min)	0.0214
5.	0.0274
6.	0.0466
7.	0.0770
8.	0.122
9.	0.186
10.	0.273
16.	1.47
20.	2.99
30.	8.13
40.	14.3
60.	36.5
80.	79.3
84.45 (max)	92.4

RMS % Error 9.92

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.21 (min)	0.0128
3.5	0.0167
4.	0.0254
5.	0.0526
6.	0.0965
7.	0.162
8.	0.253
9.	0.373
10.	0.527
16.	2.29
20.	4.30
30.	11.6
40.	20.0
50.57 (max)	27.8

RMS % Error 14.40

Life Prediction Ratio Summary

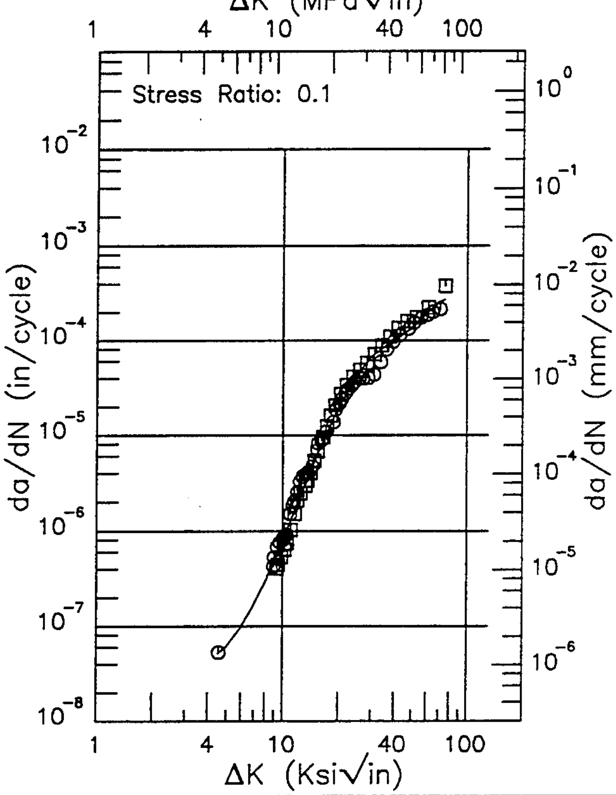
0. .5 .8 1.25 2.

Figure 4.17.3.1.37

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CT
Orientation: T–L
Frequency: 1 Hz
Environment: DIST WATER; RT

Yield Strength: 186.2 – 196.9 ksi
Ult. Strength:
Specimen Thk: 0.243 – 0.249 in.
Specimen Width: 1.997 – 2.008 in.
Ref: DA007;DA006

(1 of 2)



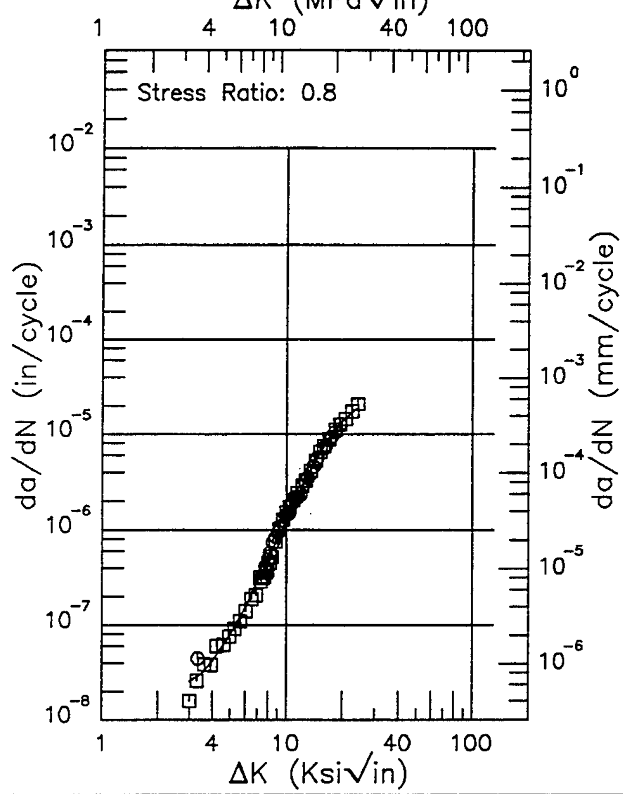
ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.53 (min)	0.0513
5.	0.0611
6.	0.0988
7.	0.169
8.	0.290
9.	0.489
10.	0.799
16.	7.59
20.	19.7
30.	66.5
40.	100.
60.	194.
75.48 (max)	271.

RMS % Error 18.86

Life Prediction Ratio Summary

0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
2.98 (min)	0.0253
3.	0.0254
3.5	0.0313
4.	0.0415
5.	0.0794
6.	0.153
7.	0.282
8.	0.491
9.	0.809
10.	1.26
16.	7.50
20.	13.8
24.07 (max)	19.2

RMS % Error 13.76

Life Prediction Ratio Summary

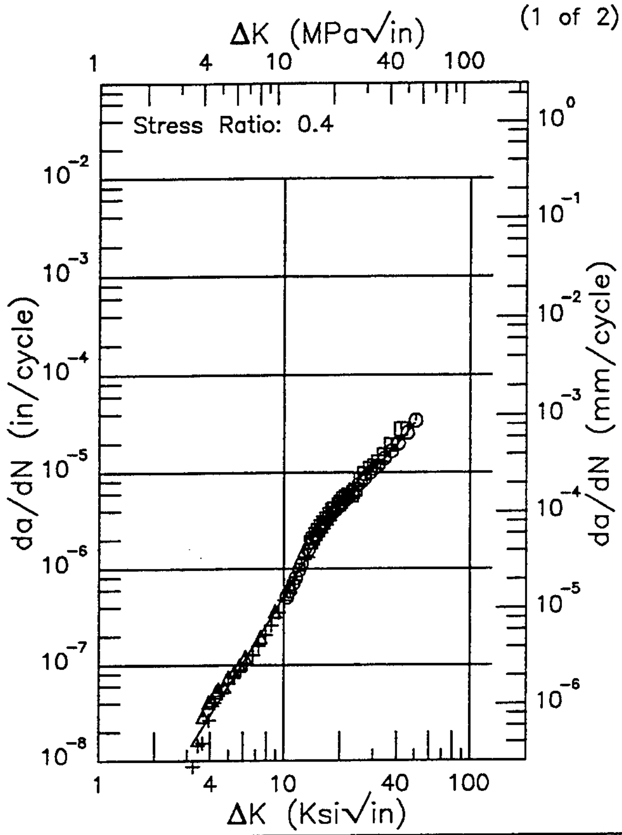
0. .5 .8 1.25 2.

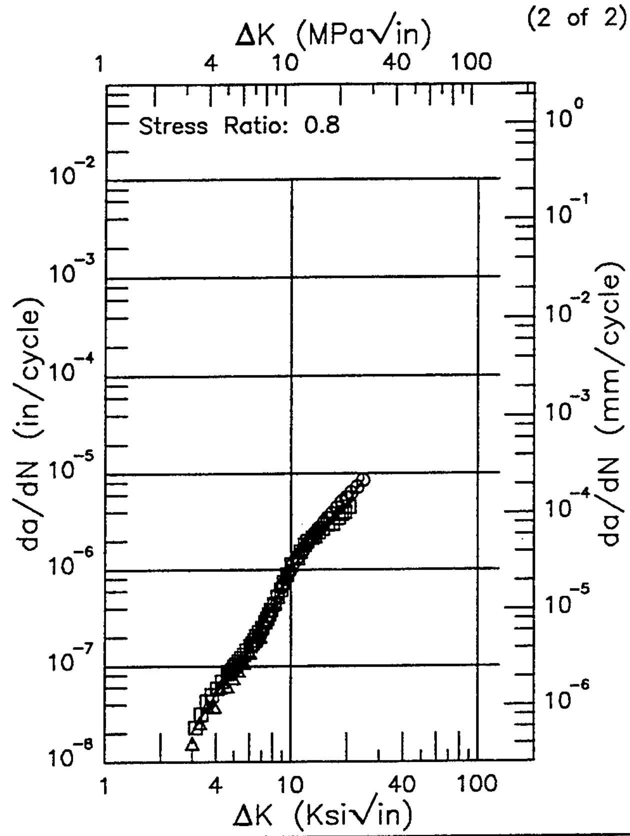
Figure 4.17.3.1.38

R

PH13–8Mo

Condition/Ht: H1050	
Form: 3 in. Forging	Yield Strength: 186.2 – 196.9 ksi
Specimen Type: CT	Ult. Strength:
Orientation: T–L	Specimen Thk: 0.247 – 0.25 in.
Frequency: 5 – 30 Hz	Specimen Width: 1.998 – 2.008 in.
Environment: LAB AIR; RT	Ref: DA006;DA007





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
3.21 (min)	0.0149
3.5	0.0196
4.	0.0299
5.	0.0600
6.	0.106
7.	0.170
8.	0.257
9.	0.371
10.	0.517
16.	2.36
20.	4.82
30.	11.5
40.	19.5
50.57 (max)	32.4

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
2.98 (min)	0.0202
3.	0.0205
3.5	0.0340
4.	0.0505
5.	0.0943
6.	0.158
7.	0.255
8.	0.403
9.	0.632
10.	0.961
13.	2.31
16.	3.18
20.	4.89
24.35 (max)	8.38

RMS % Error	Life Prediction Ratio Summary
17.12	0. .5 .8 1.25 2.

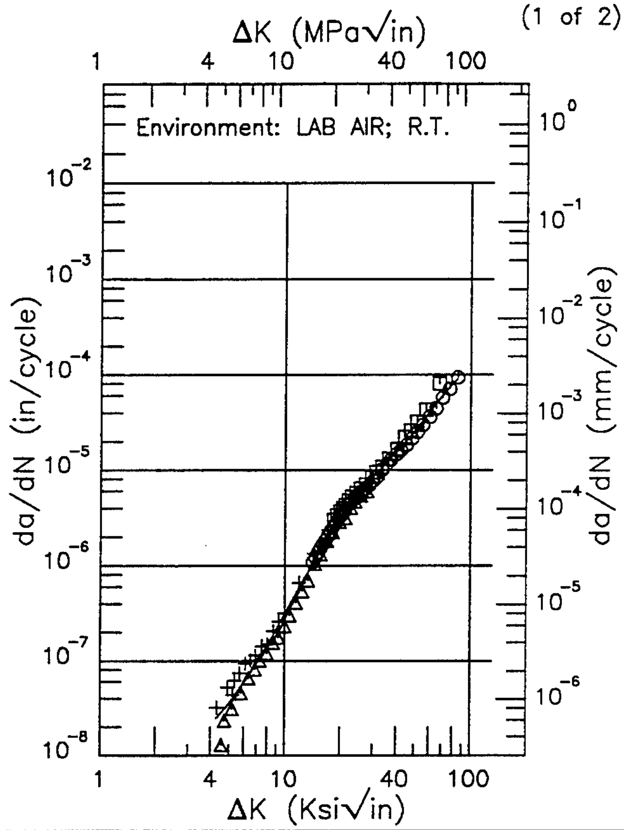
RMS % Error	Life Prediction Ratio Summary
9.33	0. .5 .8 1.25 2.

Figure 4.17.3.1.39

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CT
Orientation: T–L
Stress Ratio: 0.1
Frequency: 1 – 20 Hz

Yield Strength: 186.2 – 196.9 ksi
Ult. Strength:
Specimen Thk: 0.243 – 0.25 in.
Specimen Width: 1.996 – 2.008 in.
Ref: DA006;DA007

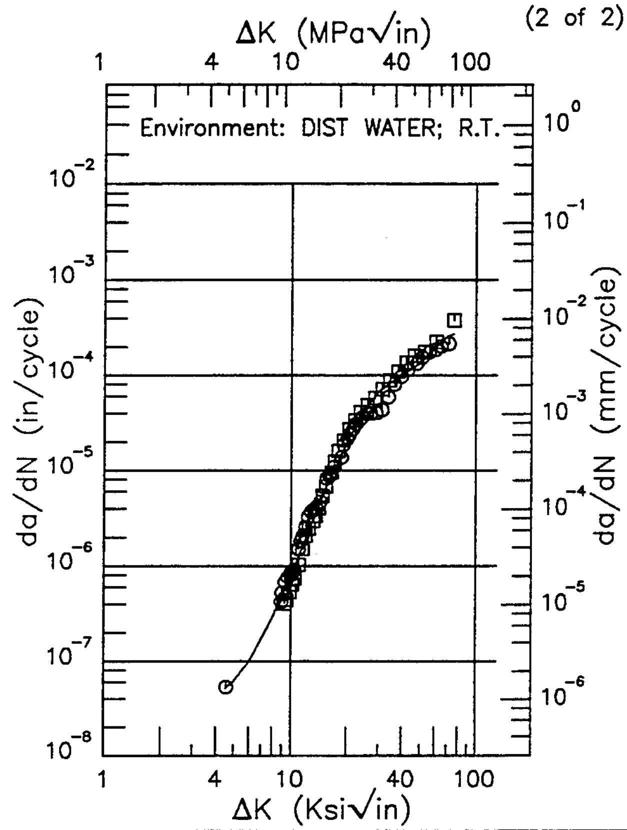
(1 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.29 (min)	0.0246
5.	0.0353
6.	0.0585
7.	0.0938
8.	0.145
9.	0.216
10.	0.310
16.	1.54
20.	3.06
30.	8.39
40.	15.3
60.	40.4
80.	80.6
84.45 (max)	90.3

RMS % Error	Life Prediction Ratio Summary
18.05	○ □ △ + ; 0. .5 .8 1.25 2.

(2 of 2)



ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
4.53 (min)	0.0513
5.	0.0611
6.	0.0988
7.	0.169
8.	0.290
9.	0.489
10.	0.799
16.	7.59
20.	19.7
30.	66.5
40.	100.
60.	194.
75.48 (max)	271.

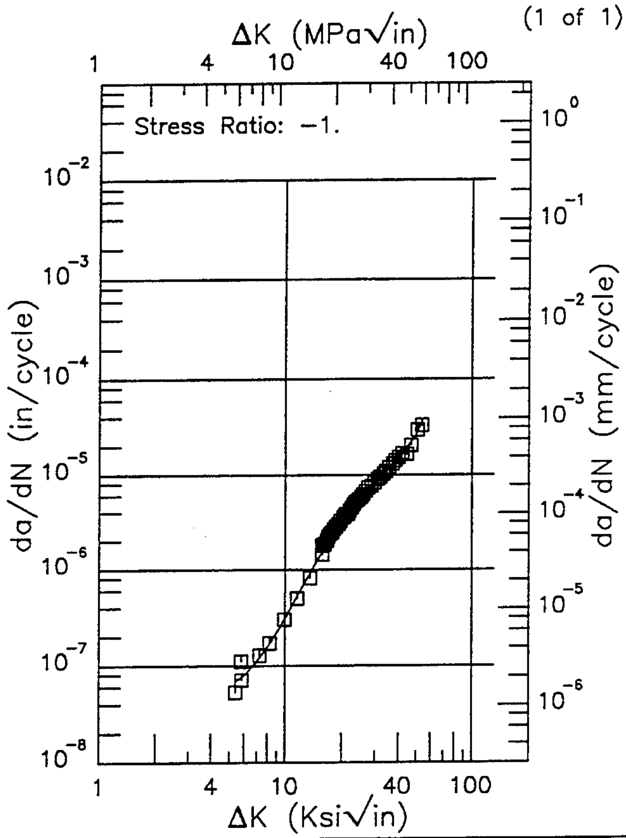
RMS % Error	Life Prediction Ratio Summary
18.86	○ □ ; 0. .5 .8 1.25 2.

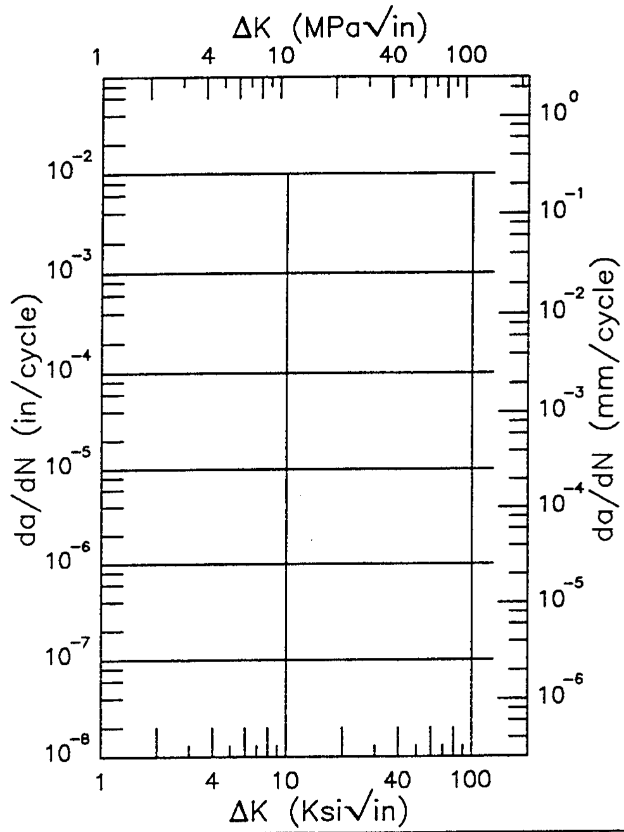
Figure 4.17.3.1.40

R PH13–8Mo

Condition/Ht: H1050
Form: 3 in. Forging
Specimen Type: CCP (max load specified)
Orientation: L–T
Frequency: 5 Hz
Environment: LAB AIR; RT

Yield Strength: 196.5 ksi
Ult. Strength:
Specimen Thk: 0.196 in.
Specimen Width: 4.009 in.
Ref: DA006





ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)
5.37 (min)	0.0676
6.	0.0796
7.	0.110
8.	0.156
9.	0.223
10.	0.314
13.	0.785
16.	1.62
20.	3.31
25.	5.90
30.	8.65
35.	11.5
40.	14.6
50.	26.6
53.32 (max)	35.6

ΔK (Ksi√in)	da/dN (10^{-6}in/cycle)

RMS % Error	Life Prediction Ratio Summary
9.70	0. .5 .8 1.25 2.

RMS % Error	Life Prediction Ratio Summary
	0. .5 .8 1.25 2.

Figure 4.17.3.1.41

TABLE 4.17.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL PH13-8MO

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
H950	F	R.T.	T-L	207.5	3.5% NaCl	CANT	1.5	0.48	4	---	73.9	73.9	60000	1971	84333
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	130	50	83520	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	131	>48	83580	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	131	>46	51720	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	130	>49	48780	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	130	>48	51720	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	131	>40	86280	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	130	46	83520	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	131	>50	86280	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	130	>48	48780	1976	RI006
H950	FB	R.T.	L-T	204	S.T.W.	DCB	5.5	1	4	---	131	>46	51720	1976	RI006
H950	B	R.T.	T-L	196.7	20% NaCl	CT	2	1	2.25	---	62.6	46	---	1973	86688
H950	B	R.T.	T-L	196.7	Industrial Atm	CT	2	1	2.25	---	62.6	59	---	1973	86688
H950	B	R.T.	T-L	196.7	Seacoast Atm	CT	2	1	2.25	---	62.6	31	---	1973	86688
H1000	E	R.T.	L-T	214	S.T.W.	DCB	5.5	1	1.5	---	132	>53	116820	1976	RI006
H1000	E	R.T.	L-T	214	S.T.W.	DCB	5.5	1	1.5	---	132	55	120840	1976	RI006
H1000	E	R.T.	L-T	214	S.T.W.	DCB	5.5	1	1.5	---	132	>52	120840	1976	RI006
H1000	E	R.T.	L-T	214	S.T.W.	DCB	5.5	1	1.5	---	132	<54	86280	1976	RI006

TABLE 4.17.3.3 (CONTINUED)

K_{Iscc} SUMMARY FOR STAINLESS STEEL PH13-8MO

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
H1000 (cont'd)	E (cont'd)	R.T. (cont'd)	L-T	214	S.T.W.	DCB	5.5	1	1.5	---	132	<53	116820	1976	RI006
			T-L	213	S.T.W.	DCB	5.5	1	1.5	---	132	<53	116820	1976	RI006
						DCB	5.5	1	1.5	---	132	>53	116820	1976	RI006
						DCB	5.5	1	1.5	---	132	>54	116820	1976	RI006
	FB	R.T.	L-T	201	S.T.W.	DCB	5.5	1	4	---	127	>80	83520	1976	RI006
						DCB	5.5	1	4	---	127	>74	51720	1976	RI006
				215	3.5% NaCl	WOL	2.549	0.998	1	1.11	---	94.8	60420	1978	GD009
						WOL	2.548	0.998	1	1.25	---	82.3	60420	1978	GD009
					S.T.W.	WOL	2.544	0.998	1	1.21	---	88.1	60420	1978	GD009
			T-L	198	S.T.W.	DCB	5.5	1	4	---	125	>71	51720	1976	RI006
						DCB	5.5	1	4	---	125	>49	83520	1976	RI006
						DCB	5.5	1	4	---	125	>49	83520	1976	RI006
						DCB	5.5	1	4	---	125	>46	83520	1976	RI006
						DCB	5.5	1	4	---	125	>68	51720	1976	RI006
				216	3.5% NaCl	WOL	2.545	0.998	1	1.88	---	63.2	60420	1978	GD009
						WOL	2.547	0.999	1	1.25	---	85.5	60420	1978	GD009
					S.T.W.	WOL	2.549	0.999	1	1.05	---	99.6	60420	1978	GD009
						WOL	2.544	0.999	1	1.05	---	99.5	60420	1978	GD009

TABLE 4.17.3.3 (CONTINUED)

K_{Iscc} SUMMARY FOR STAINLESS STEEL PH13-8MO

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen Design	Specimen Width (in)	Specimen Thick (in)	Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
H1000 (cont'd)	RB	R.T.	L-T	208	F.C.S.	DCB	5.5	1	1.5	---	132	>75	75180	1976	RI006
					S.C.S.	DCB	5.5	1	1.5	---	132	>70	75240	1976	RI006
						DCB	5.5	1	1.5	---	132	>87	60180	1976	RI006
					S.T.W.	DCB	5.5	1	1.5	---	132	>73	116820	1976	RI006
						DCB	5.5	1	1.5	---	132	70	116820	1976	RI006
						DCB	5.5	1	1.5	---	132	>73	116820	1976	RI006
						DCB	5.5	1	1.5	---	132	>73	86280	1976	RI006
			T-L	215	S.T.W.	DCB	5.5	1	1.5	---	133	>63	116820	1976	RI006
						DCB	5.5	1	1.5	---	133	>63	116820	1976	RI006
						DCB	5.5	1	1.5	---	133	>63	116820	1976	RI006
						DCB	5.5	1	1.5	---	133	>63	86280	1976	RI006
H1050	B	R.T.	T-L	178.5	20% NaCl	CT	2	1	2.25	---	87.8	65	---	1973	86688
					Industrial Atm	CT	2	1	2.25	---	87.8	83	---	1973	86688
					Seacoast Atm	CT	2	1	2.25	---	87.8	44	---	1973	86688
RH950	BR	R.T.	L-S	217	S.T.W.	CT	5.5	1	1.5	---	97	>56	120960	1976	RI006
						CT	5.5	1	1.5	---	97	>54	120960	1976	RI006
				219	S.T.W.	CT	5.5	1	1.5	---	98	>50	120960	1976	RI006
						CT	5.5	1	1.5	---	98	>51	120960	1976	RI006

TABLE 4.17.3.3 (CONCLUDED)

K_{Iscc} SUMMARY FOR STAINLESS STEEL PH13-8MO

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Refer
						Design	Width (in)	Thick (in)							
RH975	BR	R.T.	L-S	216	S.T.W.	CT	5.5	1	1.5	---	97	>67	120960	1976	RI006
						CT	5.5	1	1.5	---	97	>67	120960	1976	RI006
				219	S.T.W.	CT	5.5	1	1.5	---	98	>58	120960	1976	RI006
RH1000	BR	R.T.	L-S	215	S.T.W.	CT	5.5	1	1.5	---	96	>92	120960	1976	RI006
						CT	5.5	1	1.5	---	96	>101	120960	1976	RI006
				218	S.T.W.	CT	5.5	1	1.5	---	97	>85	120960	1976	RI006
TYS=140Ksi	P	R.T.	T-L	140	3.5% NaCl	CANT*	---	1	1	---	180	170+	---	1972	83613
TYS=180Ksi	P	R.T.	T-L	180	3.5% NaCl	CANT*	---	1	1	---	190	160+	---	1972	83613
TYS=190Ksi	P	R.T.	T-L	190	3.5% NaCl	CANT*	---	1	1	---	180	130+	---	1972	83613
TYS=200Ksi	P	R.T.	T-L	200	3.5% NaCl	CANT*	---	1	1	---	190	155+	---	1972	83613
TYS=210Ksi	P	R.T.	T-L	210	3.5% NaCl	CANT*	---	1	1	---	135	120	---	1972	83613

+ specimen thickness does not meet minimum requirements of $2.5\left(\frac{K_{Iscc}}{\sigma_{ys}}\right)^2$

* asterisk in specimen design column indicates that specimens are side-grooved

TABLE 4.18.2.2

STAINLESS STEEL PH14-8Mo K_C

CONDITION HEAT TREAT	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN		CRACK LENGTH		GROSS STRESS		K_{app}			K_C			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	INIT (in.) $2a_o$	FINAL (in.) $2a_f$	ONSET (Ksi) σ_o	MAX (Ksi) σ_{Max}	K_{app} (Ksi$\sqrt{in}$)	K_{app} MEAN	STAN DEV	K_C (Ksi$\sqrt{in}$)	K_C MEAN	STAN DEV		
BUCKLING OF CRACK EDGES RESTRAINED																			
SRH1050	SHEET	0.03	63	L-T	174.5	24.040	0.025	5.990	---	---	72.60	231.63	---	---	---	---	---	1964	57573
		0.03	R.T.	L-T	174.5	7.990	0.025	2.010	---	---	118.10	218.44*	---	---	---	---	---	1964	57573
		0.03			174.5	24.020	0.025	3.000	---	---	95.90	210.21	223.7	11.7	---	---	---	1964	57573
		0.03			174.5	24.030	0.025	6.000	---	---	72.40	231.22			---	---	---	1964	57573
		0.03			174.5	24.040	0.025	6.000	---	---	71.90	229.61			---	---	---	1964	57573
		0.05			196.6	24.010	0.050	6.000	---	---	92.10	294.15	---	---	---	---	---	1964	57573
		0.09			197.4	24.100	0.093	6.000	---	---	115.70	369.42	---	---	---	---	---	1964	57573

* NOTE: NET SECTION STRESS EXCEEDS 80% OF YIELD STRENGTH. VALUE NOT INCLUDED IN MEAN OR STANDARD DEVIATION.

TABLE 4.19.1.1

MEAN PLANE STRAIN FRACTURE TOUGHNESS FOR STAINLESS STEEL ALLOY PH15-7Mo AT ROOM TEMPERATURE

Product Form	Condition/Heat Treatment	K_{Ic} $(ksi\sqrt{in})$								
		Specimen Orientation								
		L-T			T-L			S-L		
		Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n	Mean K_{Ic}	Std Dev	n
Rolled Bar	RH950	---	---	---	30.6	0.1	2	---	---	---
	RH1050	---	---	---	40.2	1.5	3	---	---	---

TABLE 4.19.2.1

STAINLESS STEEL PH15-7MO K_{Ic}

CONDITION	PRODUCT		TEST TEMP (°F)	SPEC OR	YIELD STR (Ksi)	SPECIMEN			CRACK LENGTH (in.) A	2.5 * $(K_{Ic}/TYS)^2$ (in.)	K_{Ic}			DATE	REFER
	FORM	THICK (in.)				WIDTH (in.) W	THICK (in.) B	DESIGN			K_{Ic} (Ksi * $\sqrt{in.}$)	K_{Ic} MEAN	STAN DEV		
RH 950	Rolled Bar	1.25	R.T.	T-L	204.0	2.000	1.000	CT	1.025	0.06	30.50	30.6	0.1	1973	86688
		1.25			204.0	2.000	1.000	CT	1.007	0.06	30.70			1973	86688
RH1050	Rolled Bar	1.25	R.T.	T-L	195.0	2.000	1.000	CT	1.006	0.11	41.30	40.2	1.5	1973	86688
		1.25			195.0	2.000	1.000	CT	1.010	0.11	40.70			1973	86688
		1.25			195.0	2.000	1.000	CT	1.019	0.10	38.50			1973	86688

TABLE 4.19.3.3

K_{Iscc} SUMMARY FOR STAINLESS STEEL PH15-7MO

Condition/ Heat Treat	Prod Form	Test Temp (°F)	Spec Or.	Yield Str (Ksi)	Envir.	Specimen			Prod Thk (in)	Crack (in)	K_Q (Ksi√in)	K_{Iscc} (Ksi√in)	Test Time (min)	Test Date	Reference
						Design	Width (in)	Thick (in)							
RH950	B	R.T.	---	196.5	3.5% NaCl	CANT	1.5	0.48	1.75	---	31.5	14	30000	1971	84333
TH1050	B	R.T.	---	167.8	3.5% NaCl	CANT	1.5	0.48	1.75	---	33.6	18.5	60000	1971	84333

TABLE 4.20

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17-7PH K_{Iscc}
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AM 362 K_{Iscc}
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